MECHANICAL ENGINEERING

December 1956

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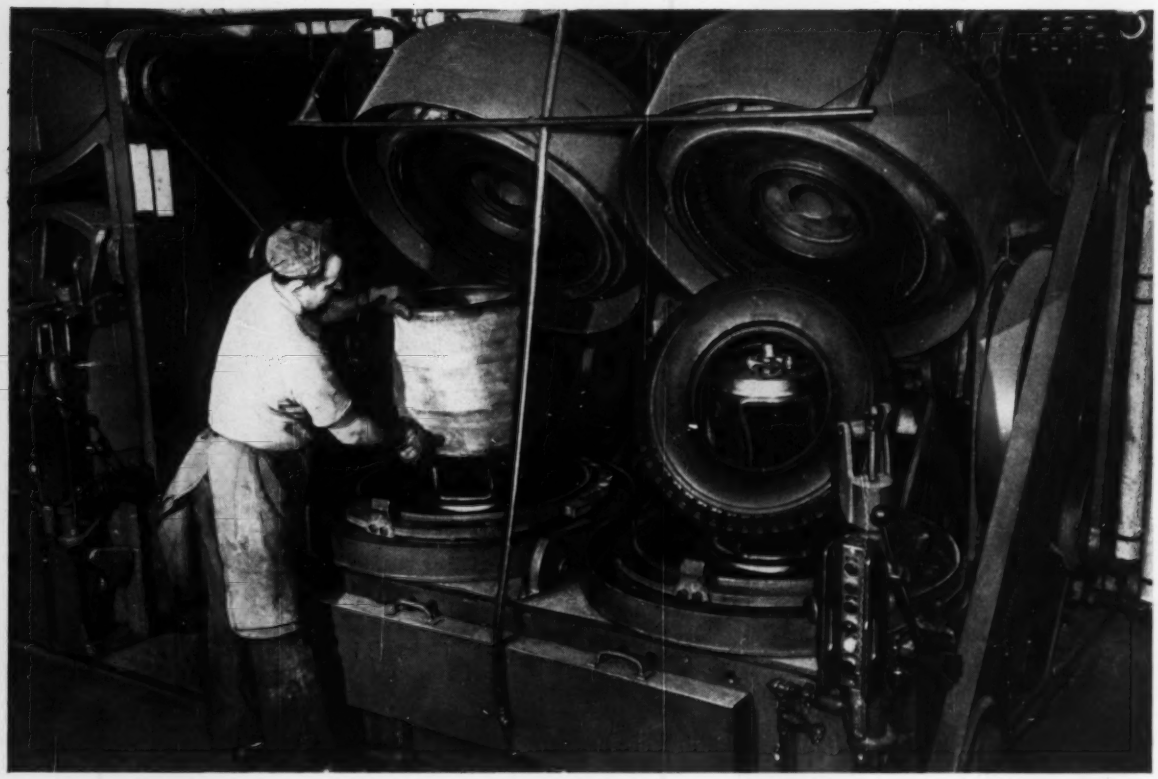


DUNLOP CUTS STEAM COST 23½% PER TIRE

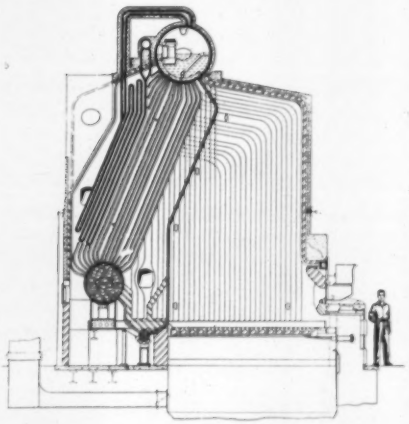
New B&W FP Boilers Burn Less Coal ... Supply Higher Temperature Steam

At Dunlop Tire & Rubber Company's Buffalo Plant, these big, modern curing presses are stepping up tire production. But they need plenty of dependable steam at fairly high temperature. The boilers they had couldn't do the job so they installed two new B&W Integral-Furnace Boilers.

These new boilers not only supply that "increased production" steam, but burn less coal and generate more steam than the old boilers, using the same limited space—a combination that cuts steam cost per tire 23½%.

Dunlop installed its first six B&W units in 1920, when the Buffalo Plant was new. Although still capable of reliable service after 37 years, the higher steam temperature demand of modern tire making has marked the four remaining old boilers for early replacement by more efficient B&W FPs.

Dunlop's experience with B&W boilers is typical of thousands of industrial, utility, commercial and institutional users. So if you use steam for power, processing or heating ... if you want to modernize or expand your plant ... if you have a steam plant problem of space or fuel or fly ash ... call B&W and get the benefit of 90 years of steam experience. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.



Each B&W FP unit can supply 40,000 lb of steam per hr at a pressure of 260 psi and temperature of 505 F. New boilers were specially designed to fit space used by old units they replaced. Zack C. Hinds, Buffalo, New York, was the Consulting Engineer on the project.

G-801-1B

BABCOCK & WILCOX

BOILER DIVISION

Season's Greetings

GM GENERAL MOTORS

NEW DEPARTURE
BALL BEARINGS

NOTHING ROLLS LIKE A BALL

MECHANICAL ENGINEERING, December, 1956, Vol. 78, No. 12. Published monthly by The American Society of Mechanical Engineers, at 20th and Northampton Sts., Easton, Pa. Editorial and Advertising departments, 29 West 39th St., New York 18, N. Y. Price to members $3.50 annually, single copy 50¢; to nonmembers $7.00 annually, single copy 75¢. Add $1.50 postage to all countries outside the United States, Canada, and the Pan-American Union. Entered as second-class matter December 21, 1920, at the Post Office at Easton, Pa., under the Act of March 3, 1879. Member of the Audit Bureau of Circulations.

IF EXTREME ACCURACY IS IMPORTANT . . IT'S A JOB FOR G.S. GEARING

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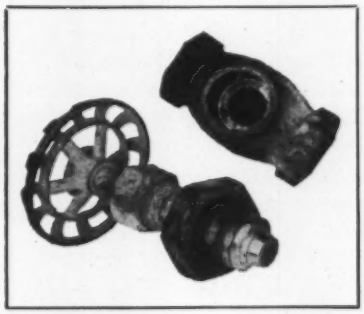
"I got 5 years of service from a valve I expected to last only 90 days"

Mr. C. L. Worthington, Chief Engineer for E. L. Bruce Co., Little Rock, Arkansas plant, standing near a Walworth No. 225P Bronze Globe Valve with "500 Brinell" stainless steel seats and discs that was installed in severe boiler blowdown service. Hardened seats and discs are especially resistant to wire drawing, steam cutting, or galling.

Some time ago Mr. C. L. Worthington, Chief Engineer for E. L. Bruce Co. plant at Little Rock, Arkansas, was having valve trouble on some newly installed boilers. The first boiler to go in service generated 600 hp operating at 200-pounds pressure. The water was so bad that a hot lime and soda ash water softener treatment had to be used, and it was necessary to add other chemicals to this solution from time to time. Mr. Worthington wanted to use a continuous blowdown to skim off the worst part of the scum on the water. He installed a small blow pipe about an inch below the normal water level in the boiler. This worked well, except that the one-inch valve on the line could only be partially opened and let a small part of the scum be blown off at one time. If the valve was widely opened, it would not take long to lower the water level in the boiler and run the steam pressure down. This service gave Mr. Worthington lots of valve trouble, as can well be imagined, because of the extreme wire drawing that occurred.



A Walworth No. 225P Bronze Globe Valve that gave perfect performance for four years and 362 days in a severe boiler blowdown service where the Chief Engineer said he had never been able to keep a valve more than 60 to 90 days.

One day the Walworth representatives in that area, called upon Mr. Worthington and demonstrated the outstanding features of the Walworth No. 225P Bronze Globe Valve. This valve, which has a working steam pressure rating of 350-pounds at 550°F, has a plug-type stainless seat and disc which has been heat treated to a minimum hardness of 500 Brinell. After listening to the Walworth men and examining a 225P valve, Mr. Worthington agreed that he would try one in the severe service described. He said if it lasted 90 days, he would consider that it had done a good job.

The valve went into service and came cut within three days of being in service five years under very severe operating conditions. The valve was used 24 hours a day from early in the morning on Monday until Saturday night, when it was closed until the following Monday morning. It was never opened more than three-quarters of a turn, and most of the time it was opened only one-half to one-quarter of a turn. For the life of the valve, nearly five years, it never failed to give a 100% closure when shut on Saturday night until opened Monday morning.

When another 600 hp 200-pound pressure boiler went into service, it also was equipped with a one-inch Walworth No. 225P Bronze Globe Valve on the same service.

In view of the severe service and the wire drawing to which this valve was subjected, it is interesting to note that the original valve (which was taken out of service almost five years after it had been installed) was removed – not because the seat and disc were wire drawn – but because the turbulence of the steam had finally caused a small hole to occur in the wall of the body of the valve. Needless to say, the valve that was taken out of service was replaced immediately by another one-inch Walworth No. 225P Bronze Globe Valve, positive assurance that Mr. Worthington is satisfied that this valve has "done a good job."

Other Walworth products include complete lines of Gate, Globe, Angle, Check and Lubricated Plug Valves in bronze, iron, steel, stainless steel and special alloys. Complete information and literature will be furnished upon request.

WALWORTH

60 East 42nd Street, New York 17, New York

SUBSIDIARIES: CLOYCO ALLOY STEEL PRODUCTS CO. CONOFLOW CORPORATION M&H VALVE & FITTINGS CO. SW SOUTHWEST FABRICATING & WELDING CO., INC. WALWORTH COMPANY OF CANADA, LTD.

Separately Fired Superheaters Cut Cost of Atomic

Con Edison's 236,000 kw Nuclear Power Plant will depend upon FW superheaters for 96,000 kw of its capacity and save about 27% in total plant cost per kw

FOSTER WHEELER will supply the superheaters for the Indian Point Plant of Consolidated Edison Company of N.Y., to be located on the Hudson River, 24 miles north of New York City. The design of these units reflects Foster Wheeler's more than 60 years of experience in building superheaters for major power plants from coast to coast—including more than 18,000 units and over 90% of all the radiant superheaters in use today.

This Indian Point project represents an important forward step toward the economical generation of electricity from nuclear power. For it is the nation's first atomic power plant to utilize separately-fired superheated steam and demonstrate the cost-saving effects of this method of generation.

Saturated steam from the new pressurized water reactor will be superheated from 447F to 1000F by two Foster Wheeler separately-fired superheaters, each with a capacity of 1,075,000 lb per hr at an operating pressure of 410 psia. Initially oil-fired, the superheater design will be such that convenient conversion to coal firing may be accomplished, if desired, at some future date.

The decision to use separately-fired superheaters for the Indian Point plant was made after detailed economic studies, comparing plant capacity and initial cost, as well as estimated annual power costs, for plants operating on saturated and superheated steam. These studies included superheating the steam from 447F to 860F, 1000F and 1050F, but the 1000F superheat was found to be the most economical. Compared to operation with saturated steam direct from the reactor to the turbine, addition of the superheat cycle raised plant capacity from 140,000 kw to 236,000 kw, and resulted in a reduction in estimated plant cost from $322 per kw to $233 per kw. These comparative cost and capacity figures are tabulated below. The use of superheated steam will also reduce turbine maintenance, further contributing to lower cost of atomic power generation.

Foster Wheeler's long experience in steam generation and specialized nuclear know-how, offers a valuable service to the power industry, for the planning and construction of both nuclear and fossil fuel fired steam plants of the future. For further information, write to *Foster Wheeler Corporation, 165 Broadway, New York 6, N.Y.*

ESTIMATED COST AND CAPACITIES

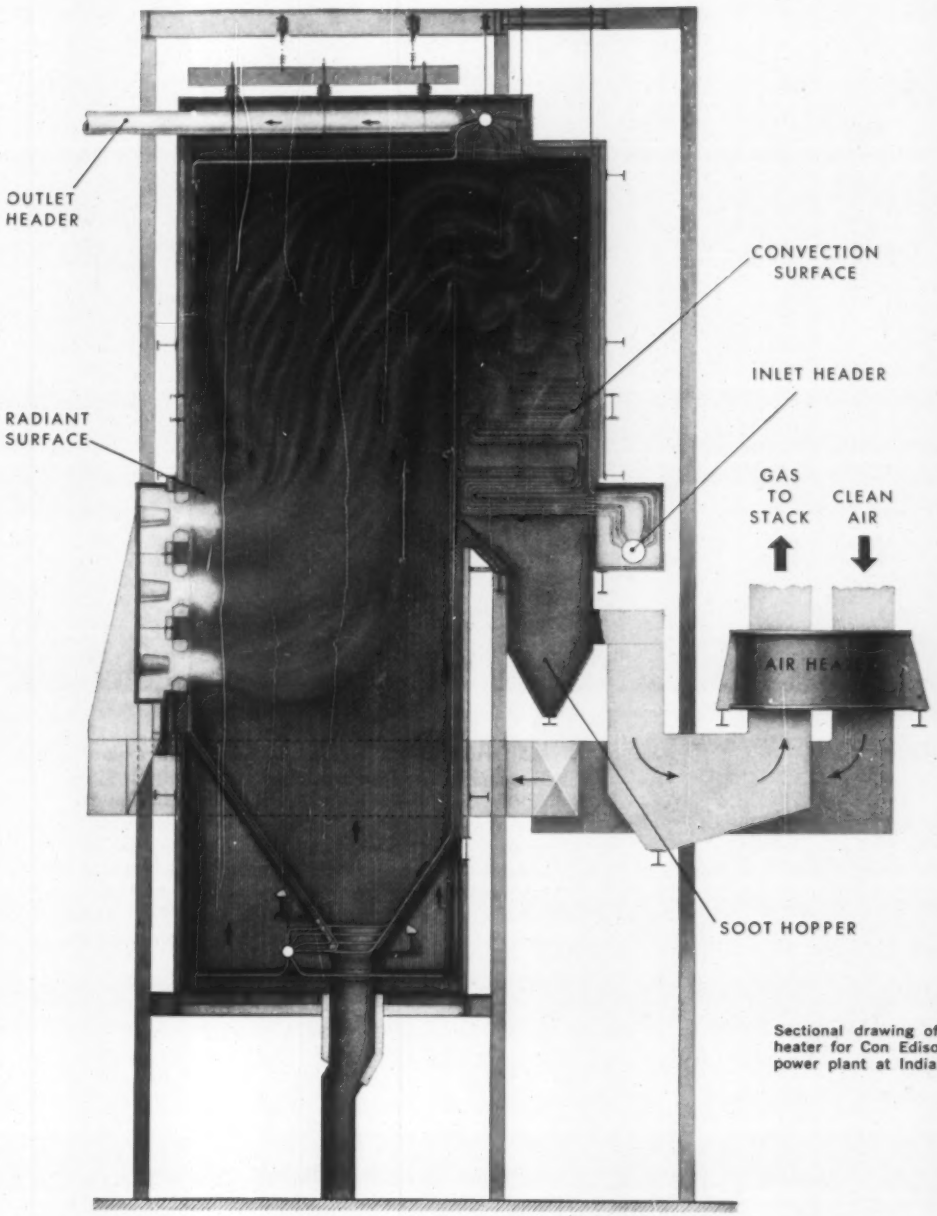
	Total Plant Cost	
	Saturated Steam	Superheated Steam
Steam Pressure at Boiler, psia.....	420	420
Steam Pressure, Turbine Inlet, psia.	405	370
Steam Temperature, Turbine Inlet..	446F	1,000F
Turbine Plant Heat Rate, Btu/kwhr..	12,900	10,700
Gross Electrical Output, kw	140,000	236,000
Total Cost of Plant, million $.....	45	55
Total Plant Cost Per kw, $.....	322	233

FOSTER

NEW YORK • LONDON

by FW

Power at Indian Point



Sectional drawing of separately-fired superheater for Con Edison's 236,000 kw nuclear power plant at Indian Point, N.Y.

WHEELER

PARIS • ST. CATHARINES, ONT.

HOW USS "T-1" STEEL IMPROVES

▲

Eliminates Normalizing. A-1 Bit and Tool Company, Houston, Texas, has converted exclusively to USS "T-1" Steel for jigs and fixtures on its turret lathes. The reason: USS "T-1" Steel, being already heat-treated, doesn't require normalizing before final machining. "T-1" doesn't warp and distort during welding, and it is easy to weld. Jigs now are machined, welded, and ready for mounting. USS "T-1" Steel saves money, speeds production, and reduces rejects.

◀

Increases Durability of Buckets. Oaks Welding, Incorporated, Columbiana, Ohio, repairs mining equipment on a custom basis. They rebuilt the 4½-yd. dragline bucket shown here with USS "T-1" Steel. Sides, bottom, and runners were made from USS "T-1" Steel . . . are actually far stronger and more durable than when the shovel was new . . . are better able to withstand severe impact abrasion in all kinds of weather.

THESE PRODUCTS:

▲ **Simplifies Fabrication.** Fairmont Machinery Company, Fairmont, West Viriginia, is using USS "T-1" Steel in thicknesses up to ⅝ inch to build an *unlined* coal storage bin. "T-1" Steel's abrasion and corrosion resistance make it an ideal choice for this type of service. In fabrication, high-yield-strength USS "T-1" Steel was cold formed on equipment normally used to form carbon steel.

This new coal storage bin will be welded in the field to cut costs. It will be simpler to build because it will need fewer stiffening members and will be lighter in weight than typical coal storage bins.

HOW IT CAN HELP YOU

USS "T-1" Steel, with its high minimum yield strength of 90,00 psi and its minimum tensile strength of 105,000 psi, can help you design or build lighter-weight equipment that will last longer. Its unusual toughness can help you design or build equipment capable of taking severe impact abuse at sub-zero temperatures. Its excellent weldability can help you to cut the cost of fabricating highly stressed parts and to reduce repair and maintenance expenses. Its good creep rupture strength can help you to put more durability in equipment that operates at temperatures as high as 900 degrees F.

Somewhere in your operation, versatile USS "T-1" Steel can help you. Write, wire, or phone United States Steel, Pittsburgh 30, Pennsylvania.

UNITED STATES STEEL CORPORATION, PITTSBURGH • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO • TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
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USS "T-1" CONSTRUCTIONAL ALLOY STEEL

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KEWANEE "CRUISING PASSES CRITICAL

■ In a hospital there can't be the slightest margin of error. Nowhere else is equipment required to pass such critical tests. Mr. Howard A. Palestine, Manager of Mid-Island Hospital, Bethpage, Long Island, puts it this way: "Like all hospitals, ours operates 24 hours a day, 7 days a week . . . and we do it with the help of such dependable equipment as Kewanee Boilers. It was the reputation which KEWANEE has built up over the years which prompted us to specify that this type of boiler system be used." Rated on nominal capacity, Kewanee Reserve Plus Rated Boilers with 50% extra built-in power, fill normal requirements in stride. Yet, they can be stepped up instantly to produce additional power needed for emergencies—for fluctuating loads. They provide for expansion too. Here you get "cruising speed" boiler operation with greater efficiency—lower fuel and maintenance costs . . . less stress and strain, plus constant protection against breakdowns and repairs. There's no necessity to operate at full speed all the time. In addition, "cruising speed" operation means you get much longer boiler life. So select Kewanee Reserve Plus Rated Boilers. You can be sure of dependable service, with savings in money too. KEWANEE BOILER DIVISION OF AMERICAN-STANDARD, 101 Franklin Street, Kewanee, Illinois.

SPEED" BOILER OPERATION TEST AT MID-ISLAND HOSPITAL

Mid-Island Hospital, Bethpage, Long Island, New York. Designed, engineered and constructed by Will N. Clurman Associates, New York, N.Y.

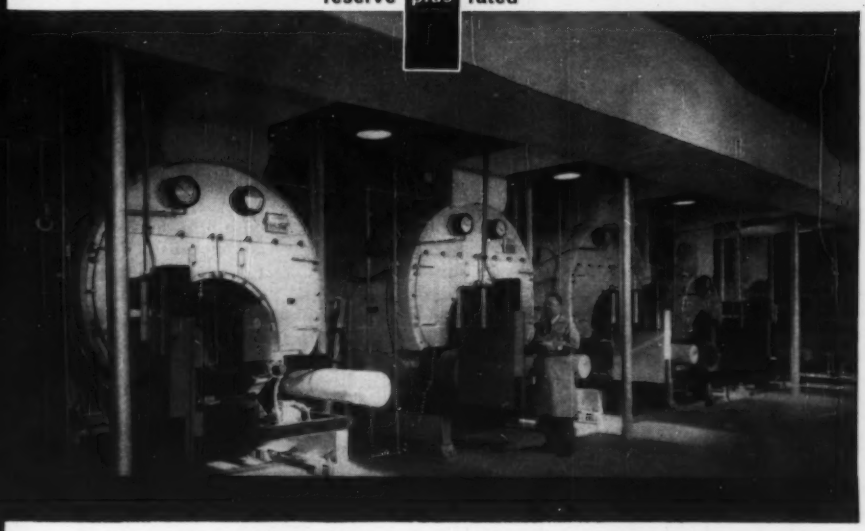
Architects: Gloster & Gloster, Rockville Center, New York.

Reception room and admitting desk of Mid-Island Hospital.

The spotless kitchen where appetizing meals are prepared.

KEWANEE

reserve plus rated



Here are five Kewanee-Iron Fireman Boiler-Burner Units which provide 'round the clock dependable service at Mid-Island Hospital.

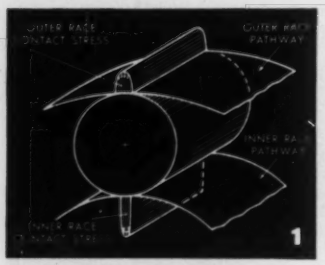
AMERICAN-Standard

KEWANEE BOILER DIVISION

Cylindrical Roller Bearing Outer Races

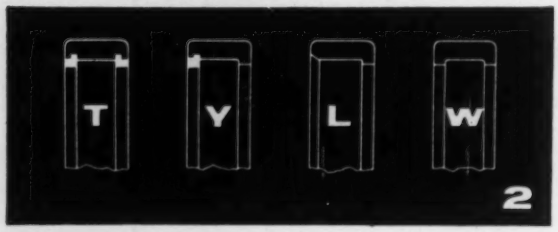
Why they are necessary . . . their importance in relation to bearing versatility . . . wide variety of configurations and locating devices

Outer races are necessary parts of all roller bearings, except in cases where a roller operating surface of suitable hardness and finish can be provided in the housing. In housings of aluminum, cast iron or unheat-treated steel where a hardened and ground surface cannot be obtained by any practical means, outer races are required to assure a fatigue-resistant pathway on which the rollers can operate smoothly.



The outer race is not normally the critical member of a cylindrical roller bearing. This does not mean, however, that outer races cannot suffer fatigue failure. All objects subjected to stress repetitions can fail after a small number of stresses—or may enjoy a surprisingly long life. But experience definitely shows that percentages favor the outer race, and the reason is apparent in Figure 1, which shows a roller engaging both an outer and inner race. Note that the load is spread over a larger area of contact on the outer race, which results in a much smaller maximum stress. This demonstrates in part the principal reason why inner races are the critical member of most cylindrical roller bearings, as explained in one of our previous messages.

Nevertheless, HYATT outer races are manufactured with the same scrupulous care that is applied to inner races and all other components of HYATT Bearings. Outer race performance must match the performance of the rest of the bearing. We consider the fact that the outer race is not the critical member as a safety factor—*not a license to reduce quality.*



1. OUTER RACE TYPES

HYATT Hy-Load outer races are available in a variety of standard configurations for every type of application requirement (Figure 2). The W, L and Y races have solid flanges capable of sustaining light or intermittent thrust loads. The T and Y races are assembled with internal snap rings; they have equal radial load-carrying capacity but are not recommended for applications where a continuous thrust would be taken by the snap rings. The T, Y, L and W races may all be mounted using the roller ends against either the solid shoulder or internal snap ring for purposes of locating the outer race axially.

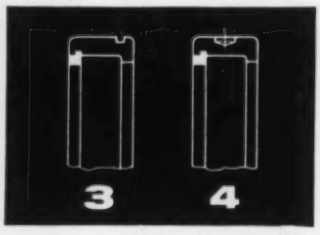
2. CIRCUMFERENTIAL LOCATION

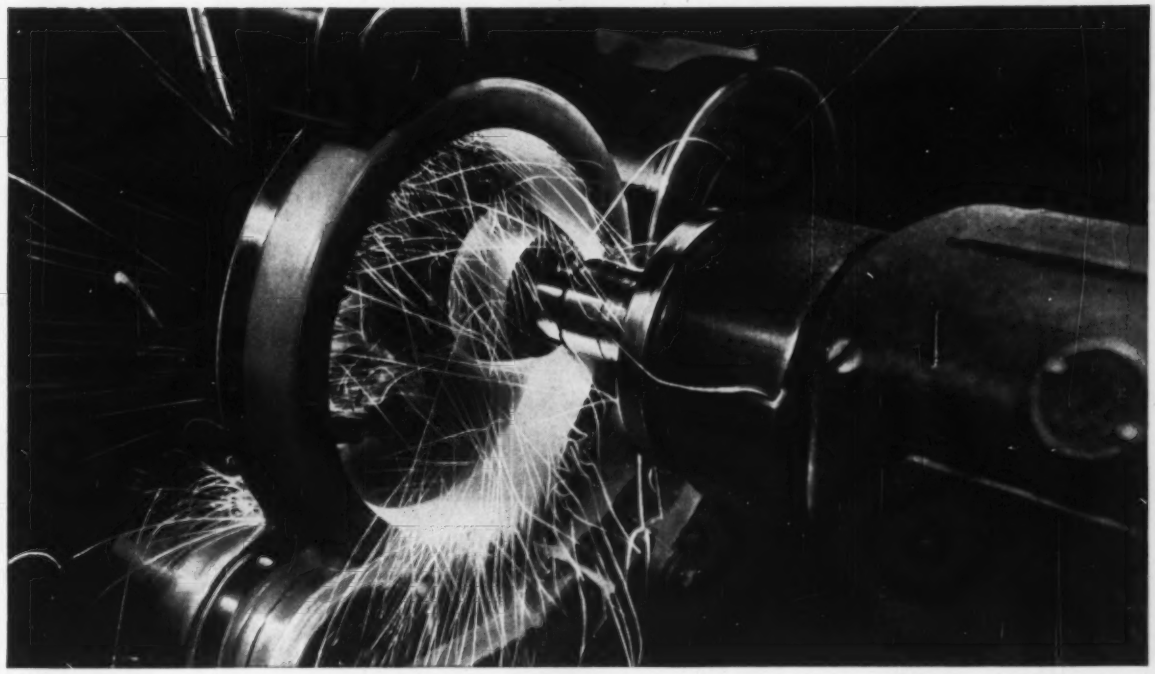
An ample choice of outer race locating methods may be used with HYATT Hy-Loads. Circumferential location is often accomplished by the use of a press fit. (Our general recommendation is that the *rotating* race be applied with a press fit and the *stationary* race be applied with a push fit.) When a push fit is employed, circumferential location is satisfactorily accomplished by axial clamping against the race ends. *Positive* circumferential location is provided by the use of an outer race dowel.

3. AXIAL LOCATION

Axial location of an outer race is conventionally accomplished by pressing or pushing the race to a housing shoulder. The race may be constrained from "walking out" of the housing bore by the flange or snap ring operating against the roller ends. *Positive* axial location is accomplished by axial clamping against a housing shoulder or snap ring.

It may occur, however, that a shoulder is not available in the housing. Under these circumstances, it is necessary to employ an auxiliary holding device such as an external snap ring or an outer race dowel. HYATT Hy-Load Bearings can be supplied to original equipment builders with outer races having a snap ring groove (Figure 3) or a blind dowel hole (Figure 4) at small added cost.





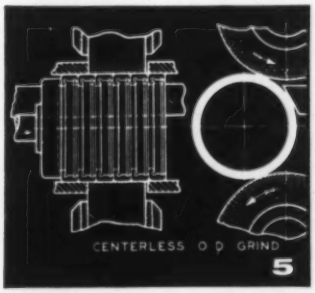
Grinding the flange on a Hyatt outer race.

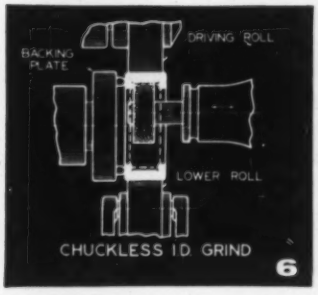
4. OPERATIONAL REQUIREMENTS

Since the outer race is usually the stationary member of the bearing, the exact maintenance of wall variations and runout is not ordinarily critical. However, the outer race *may* be the rotating race in certain applications—so quality controls are rigidly applied to all HYATT outer races to maintain:

a. Minimum wall variation. **b.** Minimum runout of race ends to bore. **c.** Minimum runout of race flange inner faces to bore. **d.** Minimum pathway and outer diameter taper. **e.** Minimum outer diameter tolerance.

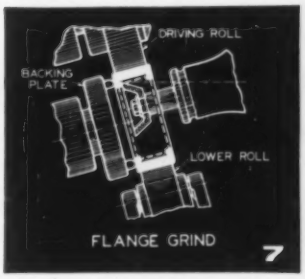
5. MANUFACTURING PROCEDURES





During manufacture, the following sequence of operations provide the controls necessary to generate outer races which meet the strict operational standards maintained by HYATT: After careful primary machining and heat treating, the ends are faced off square and parallel by a double end grind. This provides a reference surface from which all runouts and squareness can be gaged. Outer race diameters are generated by the centerless grinding method to provide an O.D. with as little out-of-round as practical. The through-feed method of grinding represents a valuable economy (Figure 5) to help reduce race costs.

Next, the pathway (or race I.D.) is ground centerless, generating a cylinder concentric with the O.D. cylinder. This is accomplished by driving the race on the O.D. and positioning the grinding wheel relative to the drive roll (Figure 6). Finally, the flanges are ground using the race ends as a reference. The result is a race of as nearly perfect geometry as is practical (Figure 7). It is then critically inspected to insure traditional HYATT dependability and the maximum possible service life.



YOU WILL FIND FURTHER DETAILS

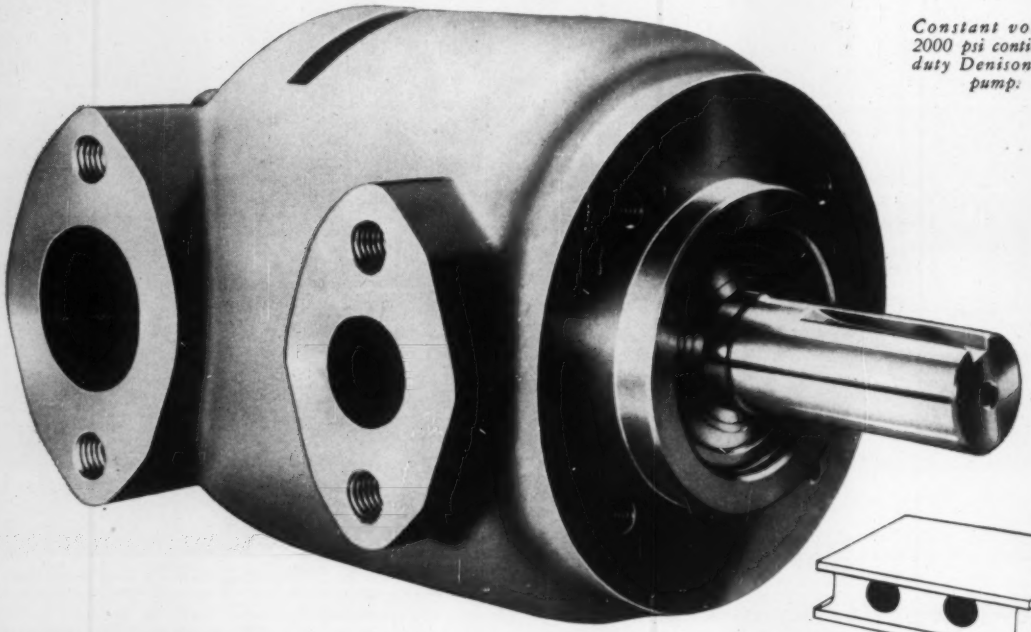
in HYATT General Catalog No. 150, or your nearby HYATT Sales Engineer will gladly help you choose the type of cylindrical roller bearings best suited to your design requirements. Remember, HYATT is America's *first* and *foremost* maker of roller bearings. Hyatt Bearings Division of General Motors, Harrison, N. J.

GM GENERAL MOTORS

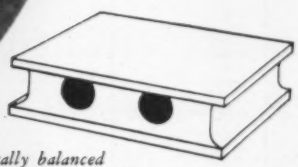
HYATT

HY-ROLL BEARINGS

FOR MODERN INDUSTRY



Constant volume 2000 psi continuous duty Denison vane pump.



Hydraulically balanced vane utilizes internal oil pressure to maintain constant pressure of sealing edges against cam ring.

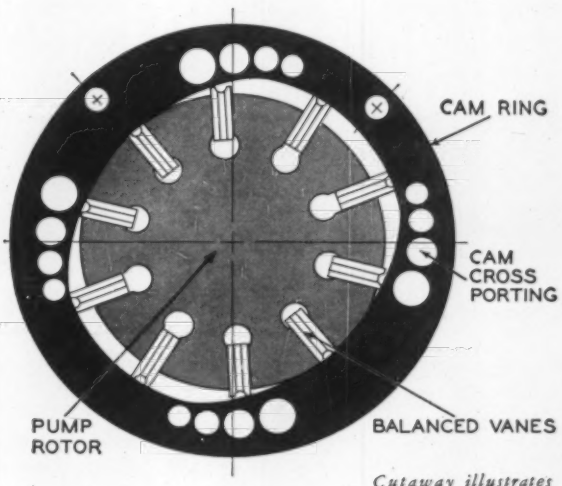
2000 PSI VANE PUMPS

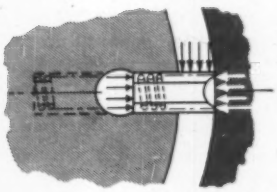
Proper Application
Hydraulic Performance
Operating Characteristics

By **Ellis H. Born**
Chief Application Engineer
Denison Engineering Division
American Brake Shoe Co.
Columbus, Ohio

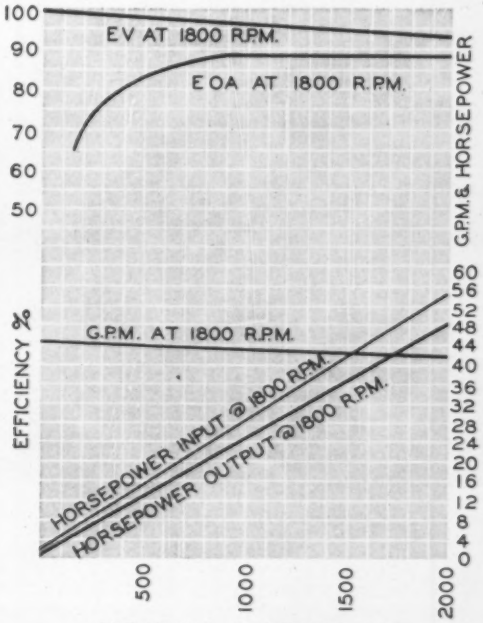
INEFFICIENCIES introduced by line loss are reduced 50% by increasing the pressure from 1000 to 2000 psi.

In designing hydraulic circuits, it is normal to limit line velocities to a maximum of from 15 to 20 feet per second, permitting the use of the smallest practical lines, valves and fittings. The pressure drop in transmitting the fluid medium is thus dependent on flow velocity, number of valves and fittings, and line length. If, for example, the pressure drop of a given system is 50 psi, this would represent a loss in transmission of 5% for a 1000 psi system and a loss of





Cutaway illustrates pump rotor and cam ring assembly. (Below) Pressure balancing relieves hydraulic bearing loads between vanes and cam ring.



Performance Curve of 2000 psi vane type pump illustrates high volumetric efficiency attained with double seal, balanced vane construction.

2.5% for a 2000 psi system. The power lost in transmission is thus reduced 50% by using 2000 psi components.

In sizing components for the transmission of a given horsepower, an interesting comparison of component size, weight and costs can be made. For example, if a job requires the transmission of 16 horsepower, a flow of 16 GPM at 2000 psi working pressure, or 32 GPM at 1000 psi, would be required. Thirty-two GPM would require 1¼" valves, but 16 GPM only ¾" valves. The use of the higher pressure results in a great advantage in that the hydraulic system can be set up with components of lower weight, lower cost per horsepower and smaller, more easily installed pumps, motors and valves.

Additional gains in hydraulic efficiencies are realized by the fully balanced design, not only on the rotor, but on the vanes themselves. Four years of field experience shows that high volumetric efficiencies are maintained over longer periods of service. Wear on cam rings is reduced over conventional designs where the vane is held against the cam ring by hydraulic pressure.

The balanced vane is achieved by a construction allowing the vane to be open at both ends to pressure on the pressure stroke, and to suction on the suction stroke.

Specifications and application data on this vane pump, which also operates as a hydraulic motor, are available by writing.

DENISON ENGINEERING DIVISION
American Brake Shoe Company
1174 Dublin Road, Columbus 16, Ohio

REQUEST FOR APPLICATION DATA

fill out and mail to
DENISON ENGINEERING DIVISION
American Brake Shoe Co.
1174 Dublin Road
Columbus 16, Ohio

Please send specific data on proper application of vane pumps for my needs. Problem is _____

_____

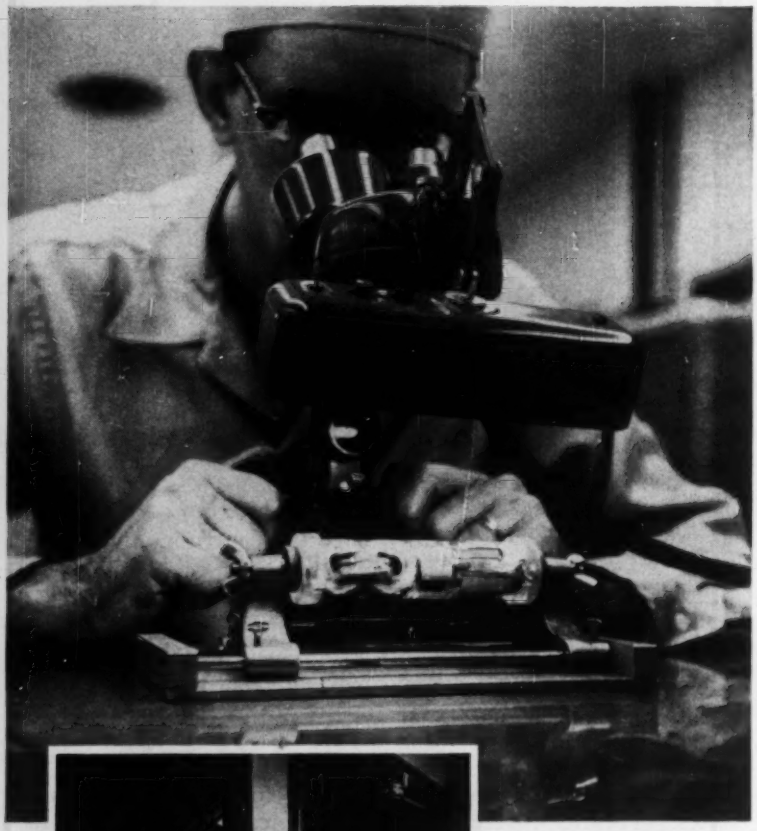
Name of Company _____

City _____ *State* _____

Name _____

Position _____

This is how Western Electric assures perfection of undersea repeaters for the new Transatlantic Cable



Even minute imperfections, visible only under the microscope, can disqualify repeater parts for use

Type CH air-conditioning Lectrodryer

51 repeaters in each of the two one-way cables make the new Transatlantic undersea telephone system possible. Designed to withstand shocks of laying and recovery, and the pressure of water at a two-mile depth, it is no wonder that Western Electric Company takes extreme care in manufacturing components.

A very low moisture content is required to obtain maximum stability and life of paper capacitors used in these repeaters. Paper, selected only after extensive life tests, is first stored in a room held below 20% relative humidity to assure that its moisture content has been reduced to that DRYness. Then the winding and assembly are done in this same room.

A Lectrodryer* maintains this room at the constant low humidity. The DRY atmosphere also reduces the perspiration from workers' hands, thereby avoiding contamination and degrading of quality. Pittsburgh Lectrodryer Company, 335 32nd Street, Pittsburgh 30, Pa. (A McGraw Electric Company Division).

In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.
In France: Stein et Roubaix, 24 Rue Erlanger, Paris XVI.
In Belgium: S. A. Belge Stein et Roubaix, 320 Rue du Moulin, Bressoux-Liege.

LECTRODRYERS DRY WITH ACTIVATED ALUMINAS

LECTRODRYER

* REGISTERED TRADEMARK U.S. PAT. OFF.

Garlock Silicone Rubber KLOZURE Oil Seals*

retain their original properties even after long exposure to temperature extremes that would quickly ruin organic rubber.

They are flexible and serviceable at temperatures as low as —90° F, and as high as 500° F . . . ideal for seals on automotive and aircraft products.

***Klozure Oil Seal with Silicone Sealing Element** for high speed, high temperature applications such as transmission cases, diesel engine crankshafts, and aircraft accessory gear cases. (Model 65 illustrated.)*

Extrusions and molded parts of Silicone Rubber are only part of "The Garlock 2,000"... two thousand different styles of packings, gaskets, and seals to meet all your needs.

It's the *only* complete line . . . that's why you get unbiased recommendations from your Garlock representative. Call him today or write for Oil Seal Catalog No. 10.

THE GARLOCK PACKING COMPANY, Palmyra, New York

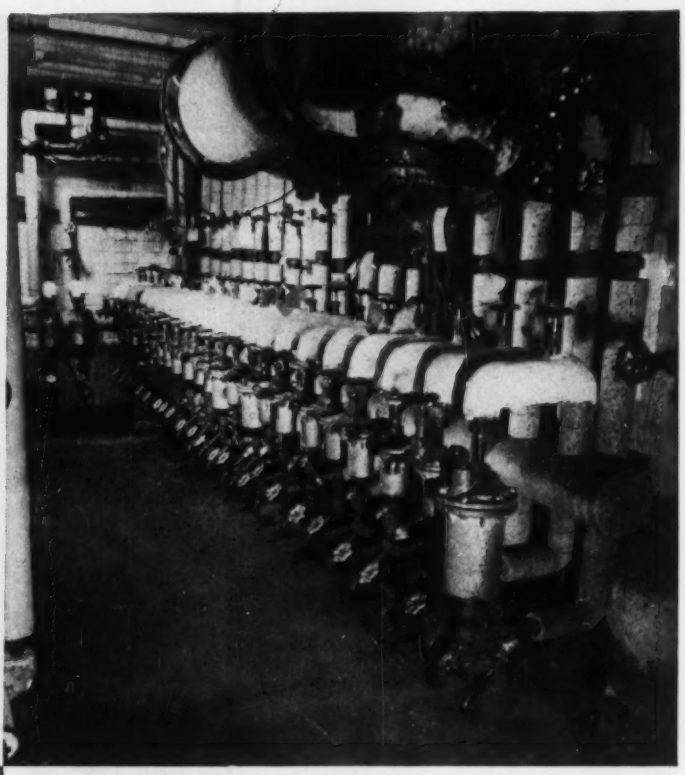
For Prompt Service, *contact one of our 30 sales offices and warehouses throughout the U.S. and Canada.*

GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Rubber Expansion Joints

**Registered Trademark*

How Steam Trap Standardization *reduces Installation and Maintenance Work and Cost*



No Bypasses Needed. Traps can be replaced in a couple of minutes by uncoupling the unions and installing a "spare" trap complete with proper length pipe connections and half unions.

ORIFICE SIZES	
PRESSURE	SIZE
0-40	7/16
40-60	3/8
60-150	5/16

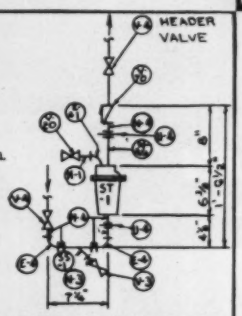
CAPACITY-0-300#/HR

NOTES:

DIMENSIONS SHOWN ARE FOR MINIMUM SPACE INSTALLATION.

IN LONG RUNS - PIPE TO BE PITCHED TOWARD TRAP.

TRAP TO BE INSTALLED BELOW DRAIN POINT IF POSSIBLE. IF NOT POSSIBLE, A CHECK VALVE MUST BE INSTALLED ON INLET SIDE OF TRAP.



BILL OF MATERIAL FOR TYPICAL STEAM TRAP HOOK-UP

MARK	REQD	MAT'L	DESCRIPTION
ST-1	1	CAST STEEL	1/2" STEAM TRAP - ARMSTRONG #211
SS-1	1	CAST STEEL	1/2" STRAINER - 250# W.S.P. - [redacted]
V-4	2	BRZ	1/2" GATE VALVE - SCRD - 200# W.S.P. - [redacted]
V-20	1	BRZ	1/2" GLOBE VALVE - SCRD - 200# W.S.P. - [redacted]
V-3	1	BRZ	1/2" GATE VALVE - SCRD - 200# W.S.P. - [redacted]
V-70	1	BRZ	1/2" CHECK VALVE - SCRD - 200# W.S.P. - [redacted]
E-4	2	FORGED STEEL	1/2" - 90° SCRD ELL - 2000#
L-41	1	FORGED STEEL	1/2" - 90° STREET ELL - 3000# - [redacted]
U-4	2	FORGED STEEL	1/2" UNION - 2000# - [redacted]
N-1	1	STL	1/2" SHORT NIPPLE - SCH. 80 - SEAMLESS ASTM A-53
N-3	1	STL	3/4" SHORT NIPPLE - SCH. 80 - SEAMLESS ASTM A-53
N-4	6	STL	1" SHORT NIPPLE - SCH. 80 - SEAMLESS ASTM A-53
N-4/4	1	STL	1"-4" LG. NIPPLE - SCH. 80 - SEAMLESS ASTM A-53

Trap Maintenance Costs Reduced $25,000 per Year with Armstrongs

Major reductions in steam trap installation and maintenance work and cost can be achieved by standardization on one make of trap which, in turn, permits standardized hookups. A major chemical company reports an annual maintenance saving of $25,000 since installing 4000 Armstrong traps according to the drawing and photograph shown here. Additionally, trap parts inventory is reduced and purchasing is simplified.

Traps of a Size Interchangeable. Note that exact dimensions are given for the pipe fittings, including nipples connected to each size of trap. When a trap needs repair, the unions can be uncoupled, the trap lifted from the line, and a "spare" carrying identical pipe connections slipped in place. In as little as one or two minutes, a faulty trap is replaced. It is then repaired and takes its place as a "spare".

$25,000 Trap Maintenance Saving. Records on the Armstrong trap installation described here show that the cost of repair parts was approximately $10,000 less annually than with the traps previously used. Reduction in maintenance labor brings the total saving to $25,000, per year. *And, fuel savings attributable to the traps are at least equal to the maintenance saving.*

Standardized hookup includes test valve for trap testing, strainer, blowdown valve for cleaning trap, shut-off valves and unions for quick replacement.

FOR COMPLETE INFORMATION on the traps that slash maintenance costs ask for the Armstrong Steam Trap Book containing complete data plus selection, installation and maintenance recommendations. Call your local Armstrong Representative or write.

ARMSTRONG MACHINE WORKS, 894 Maple Street • Three Rivers, Michigan

ARMSTRONG STEAM TRAPS

TUBE-TURN

In small piping too you get big savings by welding

Five years ago, the generally accepted practice among engineers and contractors was to weld non-critical pipe larger than 2-inches and thread the smaller sizes. Today, that dividing line has gone down; much piping as small as ½-inch is now being welded. In small piping as in large, the big reason for welding is *to save money* . . . in installation cost, in material cost, in maintenance cost. See next page for typical results. For the small pipe jobs, too, you get the *most for your money* when you specify and buy TUBE-TURN* Welding Fittings and Flanges. Your nearby Tube Turns' Distributor can give you speedy service in sizes from ½-inch to 42 inches!

The Leading Manufacturer of Welding Fittings and Flanges

TUBE TURNS LOUISVILLE 1, KENTUCKY

A Division of National Cylinder Gas Company

DISTRICT OFFICES: New York • Philadelphia • Pittsburgh • Cleveland • Detroit • Chicago • Kansas City • Denver
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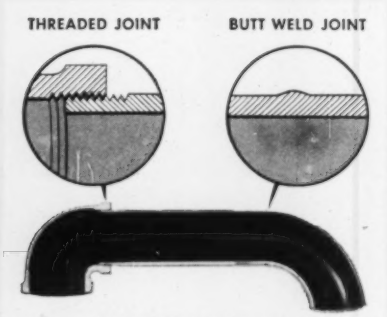
*"TUBE-TURN" and "tt" Reg. U.S. Pat. Off.

WHY IT PAYS...

SMALL DIAMETER PIPING... *why it pays to specify welded construction with* TUBE-TURN *Fittings*

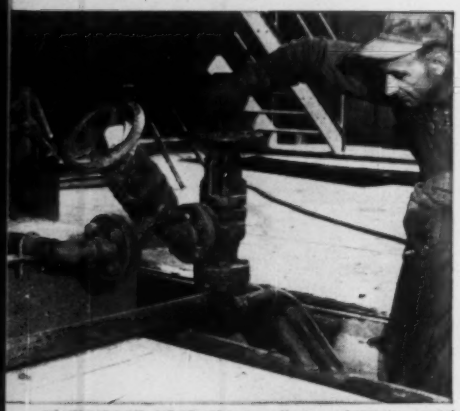
NEVER LEAKS. Welded joints are permanently as strong and leakproof as the pipe itself. Photo shows welded lube oil lines for one of four diesel engines, replacing threaded lines which leaked. If welded in first place, would have saved $4000 replacement cost. Pipe is 2½" with TUBE-TURN Fittings.



CUTAWAY SECTION
OF 2" SCHED. 40 PIPE

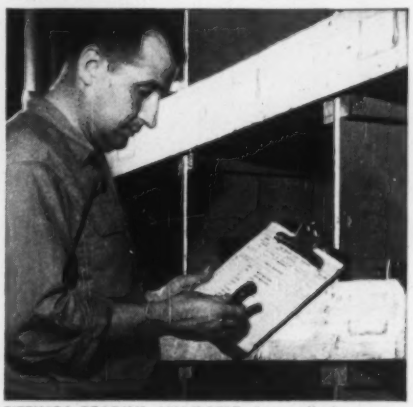
SAVES MATERIAL. Threading cuts half of pipe wall away as shown. The welded joint is as strong as the pipe. An installation of Schedule 40 pipe, welded, is stronger than Schedule 80 threaded. Hence, for equal strength welded piping can cut material costs 30-50%.

TAKES LESS TIME to weld than to thread pipe above 2" and about equal time for smaller sizes, according to recent tests on hundreds of joints made by many different pipe fitters. Welded joints in 1½" piping such as the school heating line shown, averaged 7 minutes compared to 8 minutes for threading and tightening fitting.



IS COMPACT, NEAT. This installation of 1½" and 2" boiler blow-off piping shows ability to nest welded lines close together for better layout and streamlined appearance. Also, insulation, where needed, is easier to apply.

TOOLS ARE SIMPLE. Small, inexpensive welding outfits can cut, weld, heat to bend, solder or braze. They are easy to haul to job and simple to use. All pipe for this factory radiant heating system was fabricated on the site.



FITTINGS READILY AVAILABLE. In small sizes, too, your Tube Turns Distributor is stocked to give you prompt, efficient service. Call him on *all* your needs in welding fittings and flanges . . . from ½" to 42".

TUBE TURNS, Dept. F-6
224 East Broadway, Louisville 1, Kentucky

Please send free copy of "Economics of Welding Small, Noncritical Pipe".

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Company Address _____

City _____ *Zone* ____ *State* _____

Your Name _____

Position _____

Available from your nearby TUBE TURNS' distributor

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TUBE TURNS

A DIVISION OF NATIONAL CYLINDER GAS COMPANY
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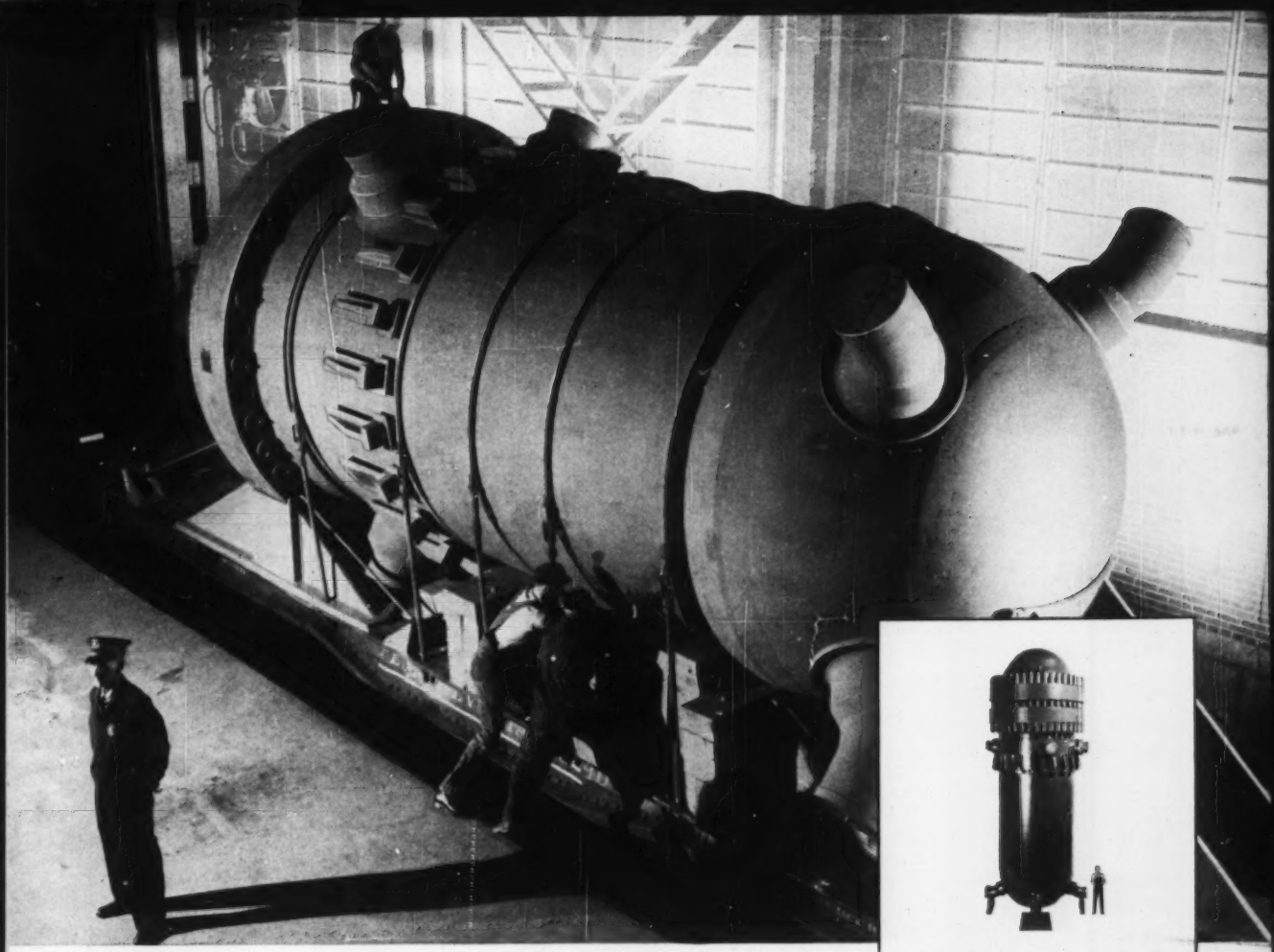

Model of the Shippingport reactor vessel with removable head in place. The completed vessel stands 3 stories high, weighs 235 tons, with some large parts machined to tolerances approaching those obtained in watch-making. 217 tons of water will pass through its nuclear core every minute —at pressures in excess of 2000 psi.

C-E delivers the world's heaviest unit of nuclear power equipment

The photograph shows a milestone on the frontier of peacetime atomic power . . . the shipment of a reactor vessel designed and built by Combustion Engineering for America's first full-scale nuclear power plant. This huge vessel – which houses the nuclear reaction within steel walls 8½ inches thick – is the heaviest unit of atomic power equipment ever built. It was shipped on a special 9-car train and is being installed in the Shippingport (Pa.) Nuclear Power Station, designed by Westinghouse Electric Corporation under contract with the A.E.C. The station will be operated by the Duquesne Light Company and is scheduled to go into service in 1957.

New machines and new techniques were developed to make possible a manufacturing precision never before achieved in a unit of this size. The final machining operation required two months on one of the world's largest boring mills. It involved the use of new optical techniques to align matching machined surfaces to the extremely high degree of accuracy specified. C-E's 15-million-volt betatron searched for defects as small as a ⅛-in. length of toothpick in welded joints up to 10 inches thick.

Combustion is actively engaged in many nuclear projects, including the design and manufacture of a complete reactor system for a submarine. Its resources of highly specialized personnel and facilities for nuclear work will enable it to play as important a role in the future use of atomic fuels as it has long played in the generation of power from conventional fuels.

COMBUSTION ENGINEERING

Combustion Engineering Building • 200 Madison Ave., New York 16, N. Y.

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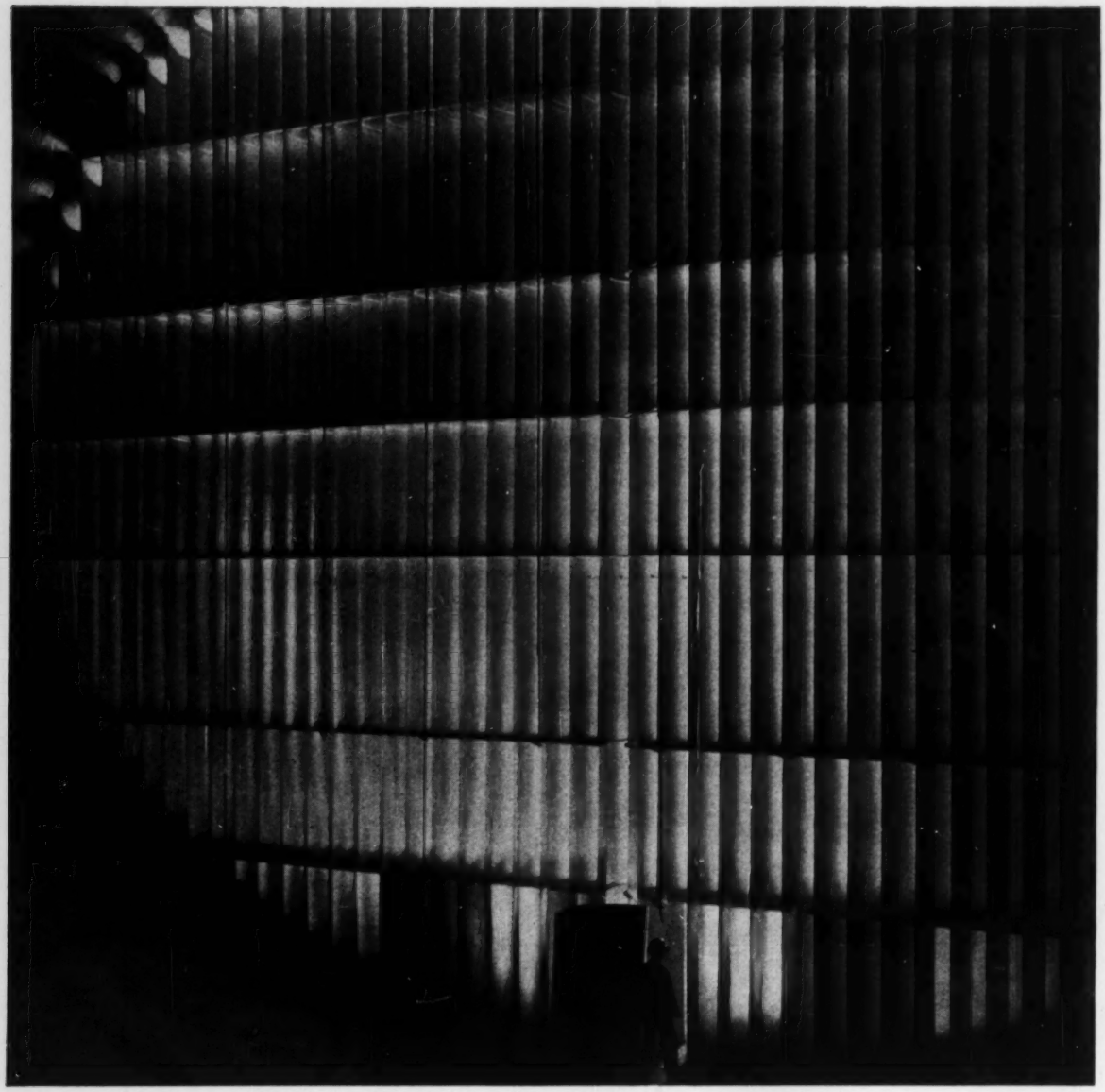
STEAM GENERATING UNITS • NUCLEAR REACTORS • PAPER MILL EQUIPMENT • PULVERIZERS • FLASH DRYING SYSTEMS • PRESSURE VESSELS • HOME HEATING AND COOLING UNITS • DOMESTIC WATER HEATERS • SOIL PIPE



Turning vanes in world's largest wind tunnel at AEDC, Tullahoma, Tennessee

"Altitude" custom-made by Hagan controls

When they test a jet engine in a test cell, engineers want the wind to behave just as it does at a given high altitude. But it won't behave that way at ground level, even when the velocity is right, unless the air is "made to order."

Hagan makes possible custom-controlled air pressure, to simulate actual flight conditions of altitudes above 80,000 feet. In test winds up to and above 1500 mph this is done with Hagan sensing devices and automatic pressure controls.

Simulated altitude control is one of many Hagan automatic control systems and components used at the Arnold Engineering Development Center, Tullahoma, Tennessee . . . one of the key installations of the U. S. Air Force's Research and Development Command.

If your operation involves *process control* in any way, Hagan can help you. Hagan produces control and instrumentation components for a great variety of process control functions . . . as well as for aerodynamic testing facilities.

See what Hagan can do for you. Write for Bulletin MSP-133-A.

HAGAN

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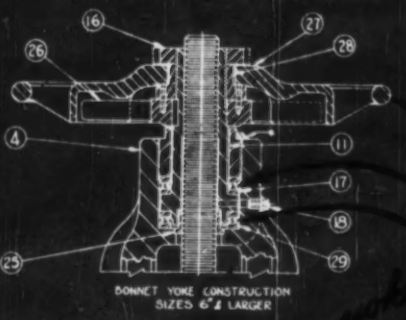
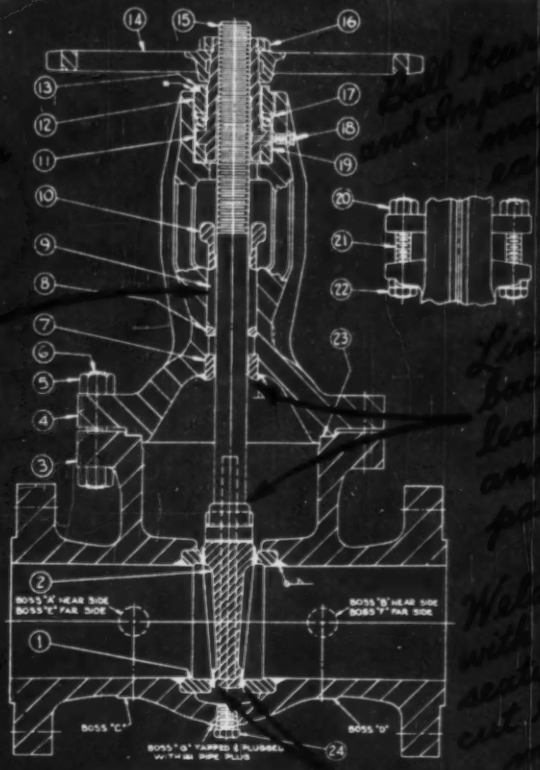
C.F.R.
Edward tests both seats simultaneously for tightness—no leakage into bonnet with these gate valves. Check these features. H.C.K.

ROCKWELL BUILT
Edward Valves



BONNET YOKE CONSTRUCTION
SIZES 6" & LARGER



BOTH END FLANGES ARE ALIKE AND HAVE 'J' DIA HOLES ON 'K' DIA B.C. STRADDLE CENTERLINE AND SPOTFACED

SECTION SHOWING CLOSELY GUIDED WEDGE IN GUIDE RIBS

WEDGE & STEM TEE HEAD CONNECTION

Deep packing chamber and preformed Evalpak packing stop stem leakage and fitting maintenance

Welded-in wedge guides are accurately aligned with seats, wedge, and each other so that wedge travels almost to a closed position before touching seats—reduces wear extends sealing life of seating surfaces.

Ball bearing yoke and Impactor handwheel make operation easy in larger Edward gate valves

Line contact backseat makes leakproof seal and protects packing.

Welded-in seats with stellited seating surfaces cut repair and maintenance costs.

Edward makes a premium gate valve—a good investment for lower operating expenses. Let's specify them

LIST OF MATERIAL
QUANTITIES ARE FOR 1 GATE VALVE

PIECE No.	NAME OF PIECE	No. REQ'D	MATERIAL	SPECIFICATIONS	EDW. M'S No.
1	SEAT	2	STAINLESS STEEL RING	STELLITE FACED	117
2	WEDGE	1	STEEL	STELLITE FACED 3/4" & LARGER	
3	BODY	1	CAST STEEL GRADE WCB	A.S.T.M. A216-C 0.30% MAX	102
			CAST STEEL GRADE WC6	A.S.T.M. A217-C 0.25% MAX	209
4	BONNET	1	CAST STEEL GRADE WCB	A.S.T.M. A216-C 0.30% MAX	102
			CAST STEEL GRADE WC6	A.S.T.M. A217-C 0.25% MAX	209
5	BONNET STUD NUTS		STEEL	A.S.T.M. A194	
6	BONNET STUDS		ALLOY STEEL	A.S.T.M. A193	
7	BONNET BUSHING	1	EVALLOY	A.S.T.M. A182, F6	212
8	JUNK RING	1	STEEL	EVALIZED	123
9	PACKING		EVALPAK	G RINGS MINIMUM	
10	GLAND	1	STEEL	A.S.T.M. A105	101
11	YOKE BUSHING	1	ONBONZE	A.S.T.M. B143 GRADE 2 part C	232
12	YOKE BUSHING LOCKNUT	1	EVALLOY	A.S.T.M. A182, F6	212
13	YOKE BUSHING LOCKNUT SET SCREW	1	STEEL		
14	HANDWHEEL	1	MALLEABLE IRON	A.S.T.M. A220 CLASS B	323
15	STEM	1	EVALLOY	A.S.T.M. A182, F6	212
16	HANDWHEEL LOCKNUT	1	STEEL	A.S.T.M. A105	121
17	UPPER BALL BEARING	1	BALL THRUST	S.A.E. STANDARD	
18	ALEMITE FITTING	1	DUTTONHEAD INDUSTRIAL TYPE		
19	LOWER BEARING PLATE	1	STEEL	EVALIZED	
20	GLAND BOLT NUT	2	STEEL CLASS 1 OR 2	A.S.T.M. A194	
21	GLAND BOLT	2	ALLOY STEEL GRADE B7	A.S.T.M. A193	
22	JAM NUT	4	STEEL CLASS 1 OR 2	A.S.T.M. A194	
23	GASKET	1	IRONKOTE (NO DIA MAX)	ARMCO IRON	
24	PIPE PLUG	1	STEEL		
25	SEALING WASHER	1	STEEL	EVALIZED	123
26	CROSS ARM	1	CAST STEEL	A.S.T.M. A216	102
27	IMPACTOR HANDWHEEL	1	CAST IRON	A.S.T.M. A126 CLASS A	
28	HANDWHEEL BUSHING	1	BRASS	COMMERCIAL QUALITY	
29	LOWER BALL BEARING	1	BALL THRUST	S.A.E. STANDARD	

Edward builds Globe and Angle Stop, Non-Return, Check, Stop-Check, Gate, Blow-Off, Mudline, Relief, Hydraulic, Instrument, Gage, and Special Valves and Strainers.

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SUBSIDIARY OF ROCKWELL MANUFACTURING CO.
EAST CHICAGO, INDIANA

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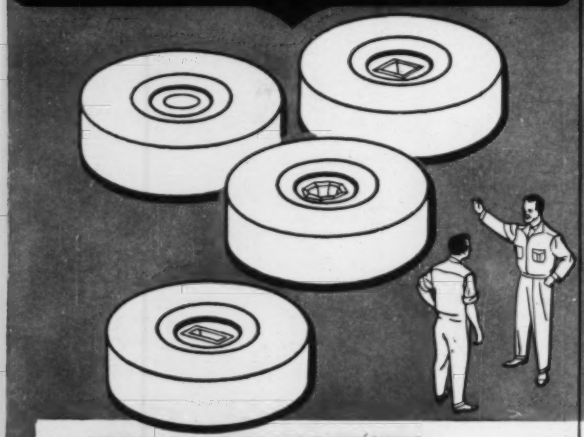
GENERAL ASSEMBLY

DRAWN [illegible] DATE: 7-17-52
CHK'D O. Peter
APP'D Tomter
DRAWING NO. AE-3207-1

A New and Better Chrome Carbide

CARMET Grade CA-815

FOR HOT EXTRUSION DIES



BETTER RESULTS

BETTER DIE LIFE
because of . . . High resistance to oxidation at elevated temperatures.

BETTER SIZE CONTROL
because of . . . Excellent wearability.

BETTER BAR FINISH
because of . . . High hot hardness.

LESS PICKUP AND GALLING
because of . . . Less affinity towards other metals.

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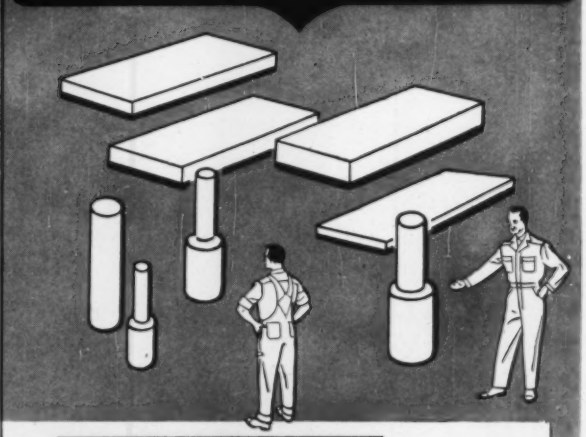

BETTER RESULTS

MORE ACCURATE GAGING
because of . . . Coefficient of expansion close to that of steel.

EXCELLENT SURFACE FINISH
because of . . . Low porosity.

EASY MAINTENANCE
because of . . . High resistance to corrosion.

LONGER GAGE LIFE
because of . . . Excellent wearability.

Write for the NEW
CARMET CATALOG

. . . Completely revised, the 16th Edition of the Carmet Catalog contains the latest information on all Carmet grades, and on Carmet blanks, tools, die sections, etc.; also gives details on special preforming and how to order special parts.

Address Dept. ME-84.

Now for the first time a completely homogeneous chrome carbide is available . . . Carmet CA-815. Grade CA-815 is ideally suited for such operations as the two illustrated above . . . or for *any* application where resistance to corrosion as well as resistance to abrasion are a factor.

Carmet CA-815 is manufactured under controlled conditions. Die and gage makers are assured of complete dimensional accuracy and excellent surface conditions. Only minimum amounts of stock are left for finishing.

For further information on this and other Carmet carbide grades, call your Carmet Engineer . . . or write *Allegheny Ludlum Steel Corporation, Carmet Division, Detroit 20, Mich.*

WSW 6155

For ALL your CARBIDE needs, call

Allegheny Ludlum

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Make speed reduction
A COST-REDUCTION FEATURE
of any drive design

When you design around the 100 SERIES, you can be sure that any model you need is available promptly, — from stock. You can be sure, also, that any BOSTON GEAR Speed Reducer will take top-rating in any test for operating efficiency, and lasting power economy.

Get complete information . . . call your local BOSTON GEAR Distributor and talk to the transmission specialist. Boston Gear Works, 66 Hayward St., Quincy, Mass.

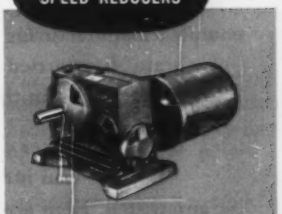
1605
types and ratios
FROM STOCK

BOSTON Gear®
100 SERIES
SPEED REDUCERS

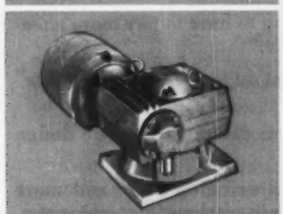
RATIOMOTORS

Output RPM
.49 to 175

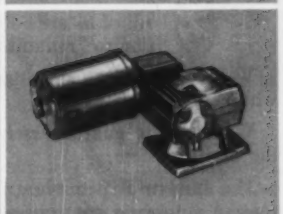
Horizontal Right Angle Drive



Double Reduction Horizontal Parallel Drive



Vertical Right Angle Drive



Double Reduction Vertical Right Angle Drive

REDUCTORS

Ratios 1:1
to 3600:1

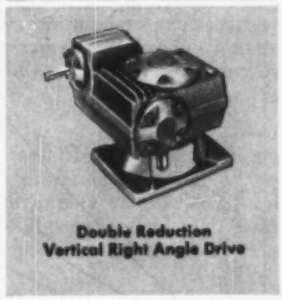
Fan-cooling optional
on larger sizes

Horizontal Right Angle Drive
Worm Gear over

Horizontal Right Angle Drive
Worm Gear under

Vertical Right Angle Drive

Double Reduction
Horizontal Parallel Drive



Double Reduction
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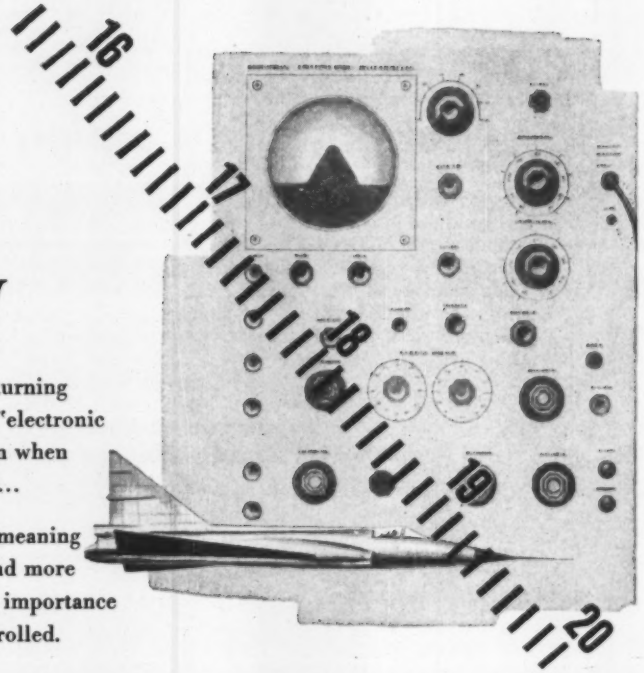
SECOND OF A SERIES

How to get reliability



Got the automation jitters?...worried about turning complex manufacturing operations over to an "electronic brain"?...worried about what can happen when one component in the control system fails?...

Reliability takes on a new and different meaning as American industry becomes more and more automated. Here are a few thoughts on the importance of reliability and how it can be controlled.

All of us are going to have to pay more attention to "reliability."

We'll have to pay more attention to individual "devices" within a system.

We'll have to guard ourselves carefully when we design the entire system.

The industrial pendulum is swinging more and more toward automatic controls, servo-mechanisms, computers, and automatic "watchers." As it does, the reliability factor becomes more and more important. Let's see why. For example, you probably have three radios at home. If one fails because a soldered joint comes apart, your home life is probably not disrupted to any alarming degree. But... consider the automatically controlled steel mill. One soldered joint failing, unless all controls are installed in duplicate (which is expensive) could tie up the entire production process for valuable minutes, if the maintenance crew has second sight. For hours, if automatic trouble-indicating and locating systems are not installed (and these are expensive, too). Last, but not least, lend a thought to the dependence of guided missiles and man-made satellites upon the reliability of electronic circuits and components. So... let's start to examine "reliability." Let's begin by looking at this definition which is currently popular in the technical field:

The reliability of a particular component or system of components is the probability that it will do what it is supposed to do under operating conditions for a specified operating time.

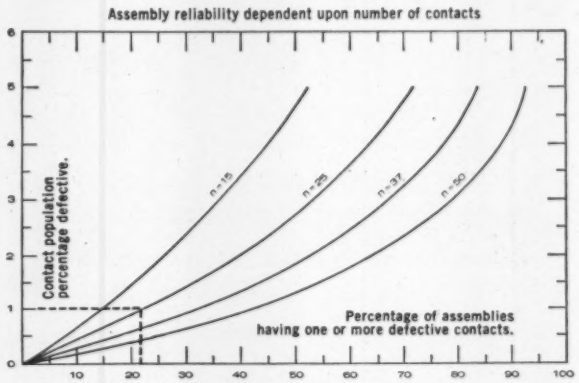
Now... this is a relatively well-accepted definition, and it offers the key to the problem of coping with failure control. Take the word "probability" in this definition. Let's discuss its implication.

Many of today's systems, simple or complex, are a chain of components. So picture a system as a chain with its successive links. In the field of statistics the over-all reliability of the chain is the mathematical product of the reliabilities of the individual links...

Overall Reliability, $R_o = r_1 \times r_2 \times r_3 \ldots r_n$

Now, let's consider a system made up of 100 different components, each of which has a reliability of 99%. In applying the formula, multiplication of .99 by itself 100 times gives an over-all reliability for the system of only 36.5%. Two out of three systems you have put together will probably fail!

Cannon becomes involved with this problem because our main business is making electric connectors. So, let's look at the following chart that covers contact reliabilities and reliability of the assembly in which they are mounted.



This chart illustrates the reliability of four connectors having 15, 25, 37 and 50 contacts respectively. As an example, assume that the contacts have a contact population of 1% defective (1 in 100 defective ... this percentage is considered a fairly high standard in most fields). On the 15-contact assembly, we find from our chart that 14% of the connector assemblies would have one or more defective contacts! With 25 contacts, 22% would have one or more defective contacts. With 50 contacts, 41½% ... is your hair starting to curl? Obviously, a 99% contact reliability standard for guided missile components is absolutely unacceptable. And, in between the simplest system and that of a guided missile, are hundreds of assemblies and systems whose reliability factors must be analyzed with utmost care.

But all is not lost! There's another side to the picture. With proper care, analysis, and control, our Cannon organization has actually achieved, in special "missile quality" contacts, a known level of only 2.85×10^{-3}% defective ... only 1 part in 35,000! Naturally, we don't achieve that with all our contacts ... but we do try to design and manufacture the utmost in reliability required for specific applications.

We have pictured this chart to show the direction we must all take, whether we're talking about connectors, other components, or systems. It boils down to two steps ...

* The number (n) of components must be kept low ... *simplicity*.
* The level of component reliability must constantly be improved ... *hard work for all of us*.

Now ... if we refer to our reliability definition on the previous page we note the phrase "do what it is supposed to do." So be sure *you* define these objectives for your component assembly, or system ... failure to do so carefully can cause undue failure or the expenditure of unnecessary dollars for needless, excessively-reliable parts or design.

Further on in the same definition, we note the words "operating conditions." This brings up many new points for consideration. Here we are concerned with such things as temperature, pressure, humidity, corrosive atmosphere, stray electric and magnetic fields, low and high frequency noise, shock and vibration. Do your design standards need upgrading? Are your components designed and then tested to meet the operating conditions you specify ... or are they designed to meet "average" conditions? Are you using adequate "safety factors"?

In a simple component, manufacturers have always looked for, recognized, and corrected faults when they occurred. We use component quality control to achieve and maintain Cannon's world famous product quality. But in complex systems such component quality control is not enough. Actually ...

Reliability control over the system is needed. It should be all-encompassing. When you get right down to it, *reliability* is the product of procedures, equipment, and people ... in the design, manufacture, testing, control of quality, transportation, and use of products or systems.

Do you have a reliability control system?

Here are a few of the steps that are needed to get a reliability control system operating:

1. Determine Your Requirements. Specify the environment, operating time, performance limits, and the percent of reliability required. Allow an adequate safety factor keeping in mind the end use of the finished product.

2. Collect Reliability Data. Set up facilities for the continuous accumulation of data on component or system failures and their causes.

3. Establish quality control and test procedures which show high degree of correlation with end-use conditions.

4. Analyze. Determine if reliability requirements are being met. Establish the most important causes of failure by analyzing the data you collect.

5. Improve. Take action to eliminate the most important defects or causes of failure. Reduce the failure rate to the required level.

6. Maintain Continuous Vigilance. You have emphasized system design ... you have used statistical analysis of failures ... now exert continuous and critical control to be sure your "improvements" actually improve reliability. Examine new and unforeseen failure sources. Review and modify your requirements with changing conditions.

*

We at Cannon Electric are proud of our historical emphasis on quality and reliability. Since 1915 we have adhered to a design philosophy embracing the highest quality and reliability in each and every Cannon Plug for the specific application for which it is to be used. *If we can't design to that principle, we don't make it!* In manufacture, we are proud of our know-how in depth, proud of our fine quality control systems, proud of our personnel and proud of our reliability control group.

Whenever *you* have an electric connector reliability problem ... in design, engineering, production, or prototype phases ... we would appreciate the opportunity of discussing it with you.

Cordially,

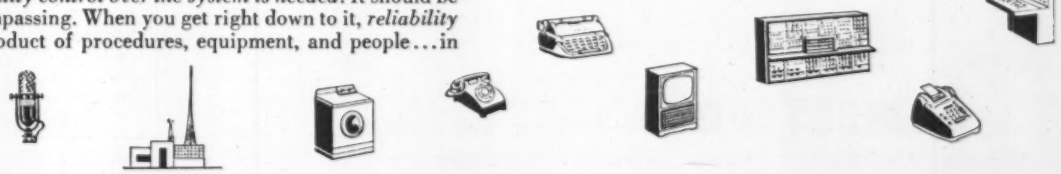
Robert J. Cannon *President*

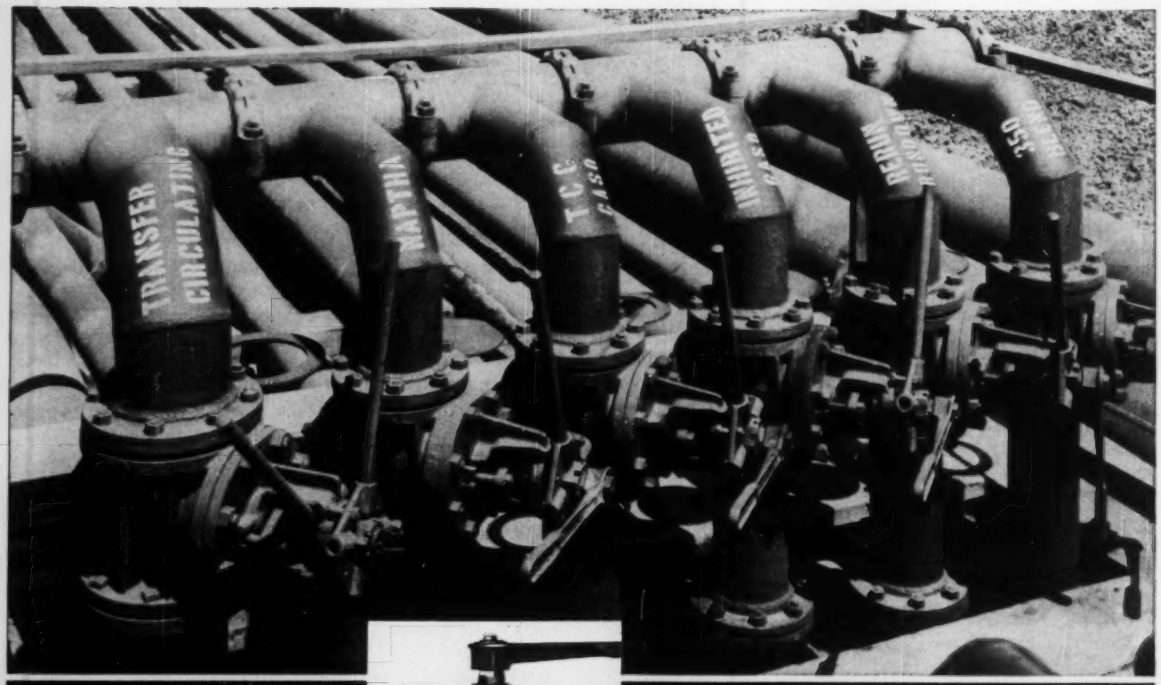
CANNON ELECTRIC COMPANY
3208 Humboldt St., Los Angeles 31, California

CANNON PLUGS

Eight plants around the seven seas!

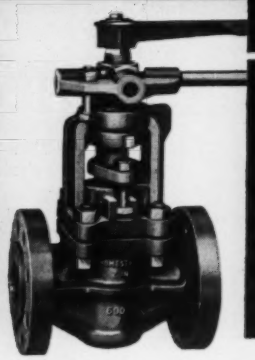
Please Refer to Dept. 417





if your problem is...

- TEMPERATURE
- PRESSURE
- CORROSION...



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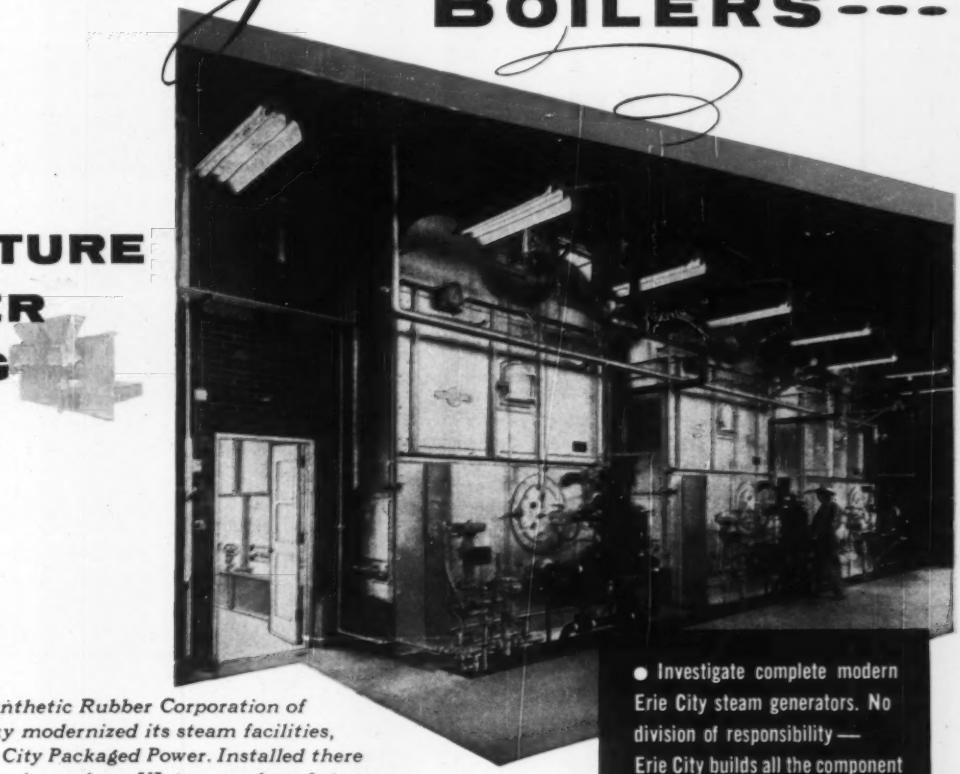

When American Synthetic Rubber Corporation of Louisville, Kentucky modernized its steam facilities, they turned to Erie City Packaged Power. Installed there are three 25,000 pounds per hour VL type packaged steam generators complete with Erie City steam atomizing combination gas and oil burners and arranged for the future installation of Erie City Underfeed Stokers.

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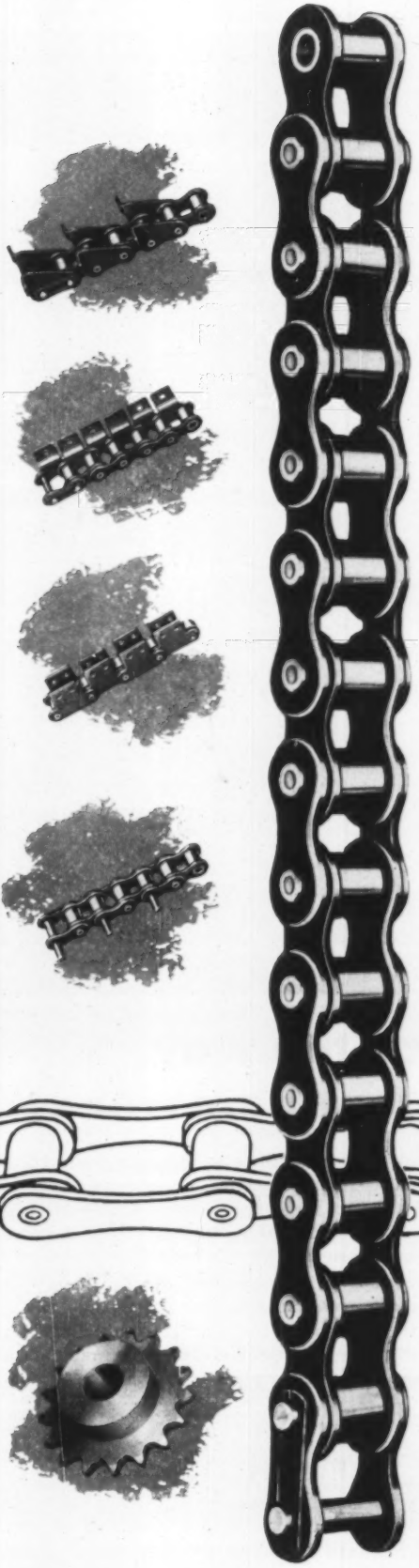

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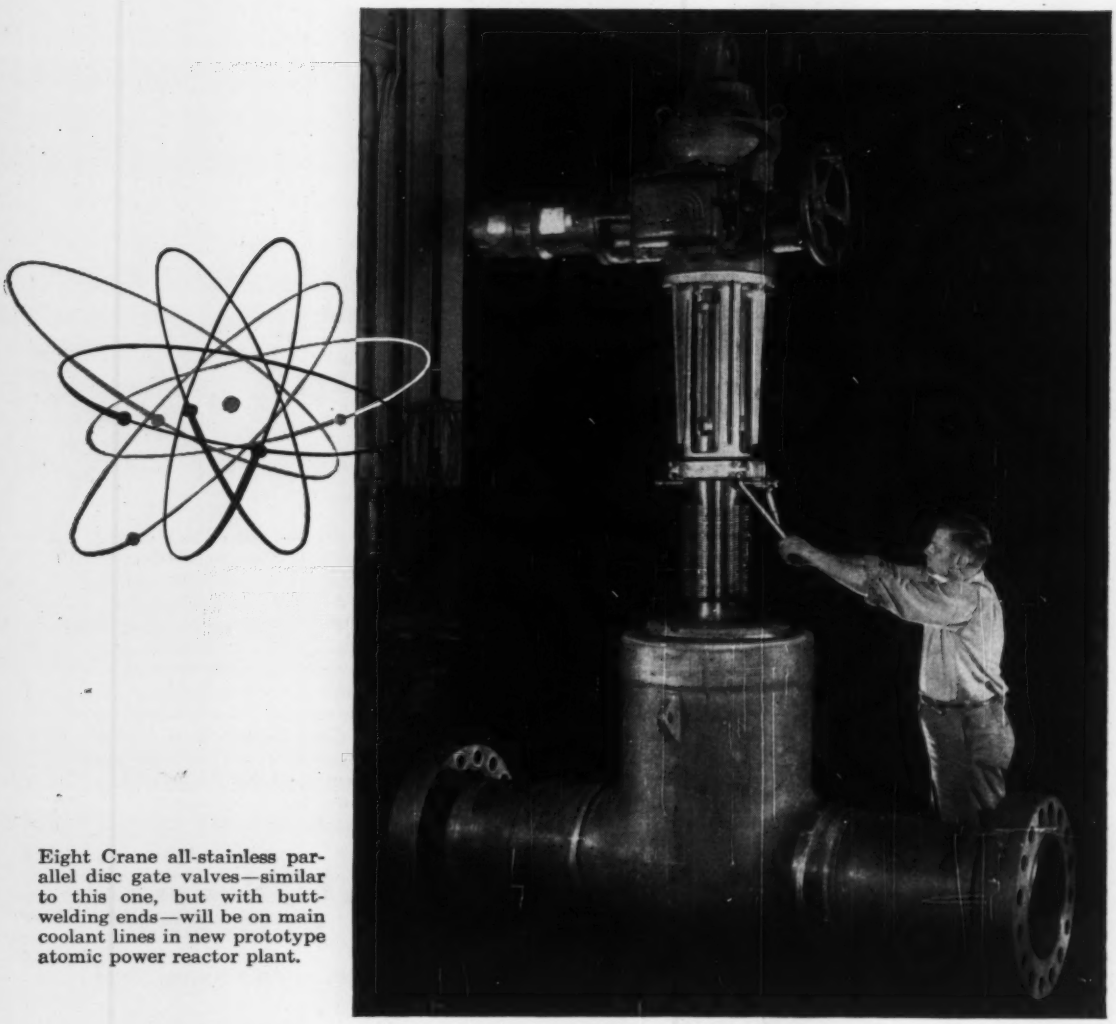

Eight Crane all-stainless parallel disc gate valves—similar to this one, but with butt-welding ends—will be on main coolant lines in new prototype atomic power reactor plant.

AGAIN... Crane leads the way in flow control for atomic power

As the age of atomic power unfolds and expands, Crane continues to lead the way in flow control.

Crane equipment is already playing an important role in the mighty *Nautilus* and *Seawolf*—the Navy's celebrated atomic-powered submarines.

Now Crane valves are ready to make history again in the peaceful use of atomic energy—in the nation's first land-based atomic power plant.

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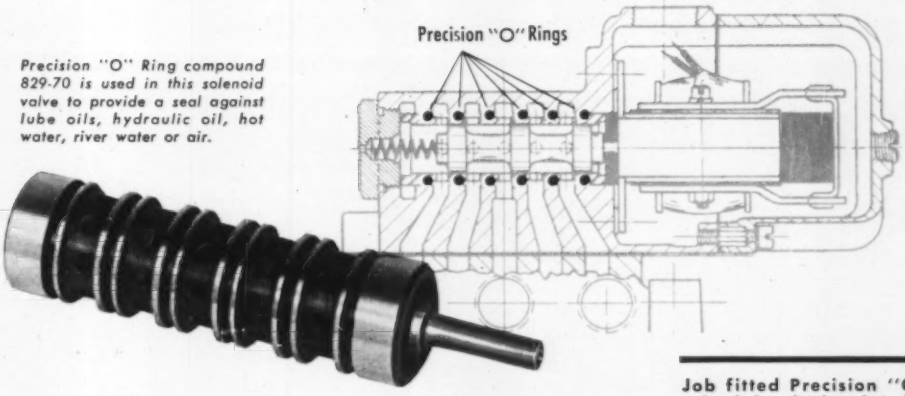

Job fitted Precision "O" Rings have solved hundreds of industrial, aircraft and automotive sealing problems.

Uniformity of size, excellent surface quality, compatability with a wide range of fluids . . . Numatics, Inc. of Milford, Michigan, cite these as reasons why "O" rings made from Precision Compound 829-70 are being used in their solenoid valves. They are giving service through more than 30,000,000 valving actions.

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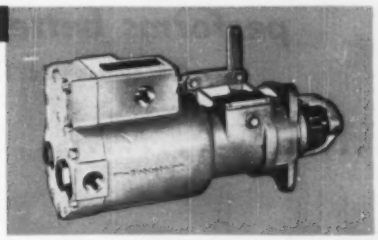
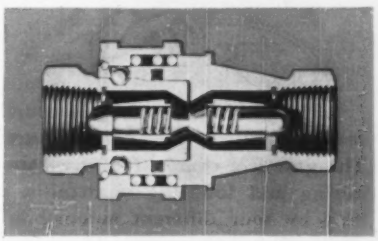
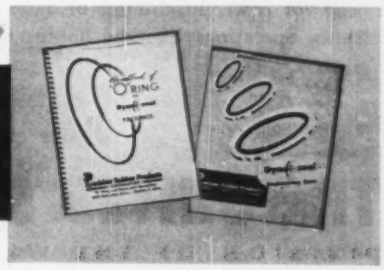


Precision "O" Rings were selected for this cranking motor after exhaustive tests for flexibility and sealing in arctic cold.



In this coupling, an "O" ring made from Precision Compound 829-70 seals against hydraulic fluids and pneumatics.

Write or your free copies of Precision catalogs on "O" Rings and Dyna-seals



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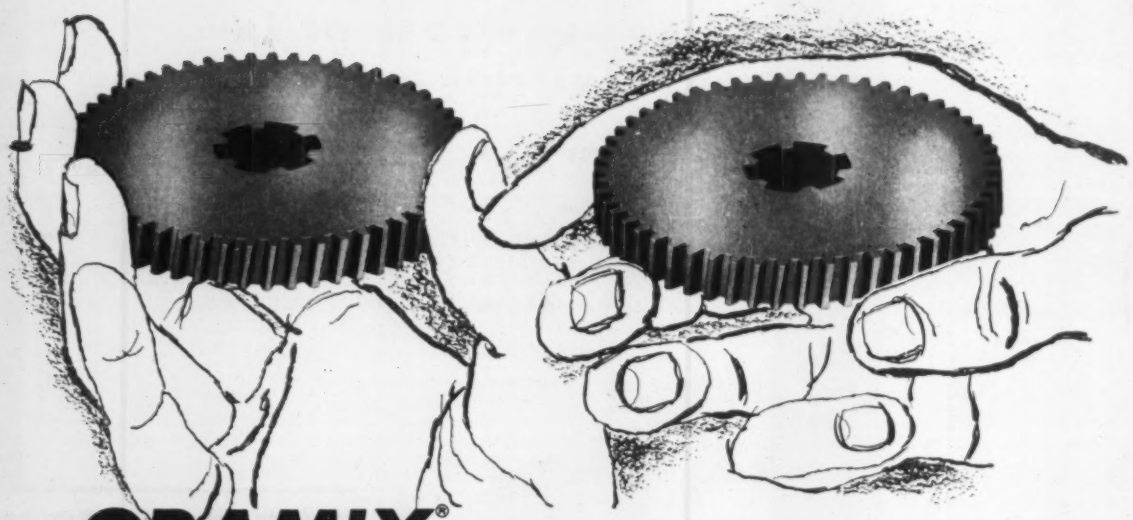
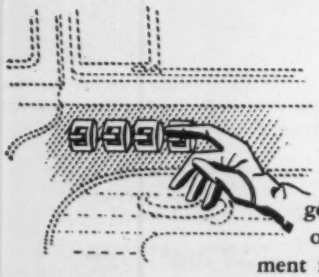
which helical gear costs 80% less?



the GRAMIX® sintered metal helical gear performs better than a forged and hobbed aluminum part for just 1/5 the cost!



By replacing forged aluminum gears with sintered steel GRAMIX helical gears, a manufacturer of automotive equipment found that he could realize an 80% saving and get greater dependability. The gear is a component of an automatic window raising and lowering mechanism currently being used by four different automobile manufacturers. The helical teeth are formed in the compacting dies, and, after sintering, the GRAMIX gear is ready for assembly into the power window unit . . . there is no need for costly machining or time-consuming finishing operations like the hobbed aluminum gear used previously. In spite of the astonishing savings, these GRAMIX gears have proven to be even better than the former forged gear from a standpoint of toughness and wearability.

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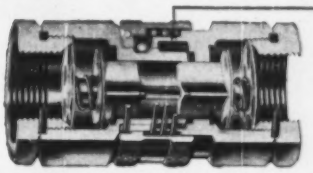
FOR HYDRAULIC OR AIR

"H" Coupling for high strength, higher efficiency, high-resistance to heavy line surge. Sizes: ⅛" thru 12". Bulletin No. 240



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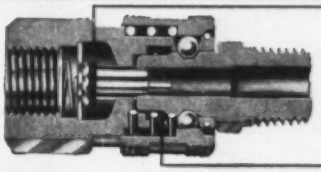

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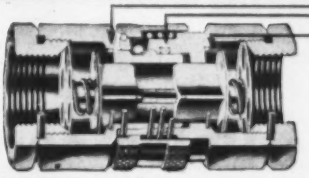

Teflon Valve Seal

Teflon Nipple Seal

Teflon Valve Seal

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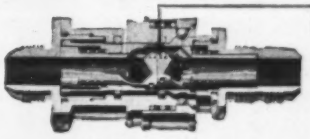

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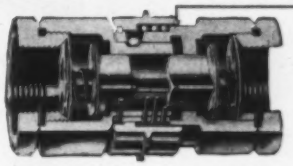

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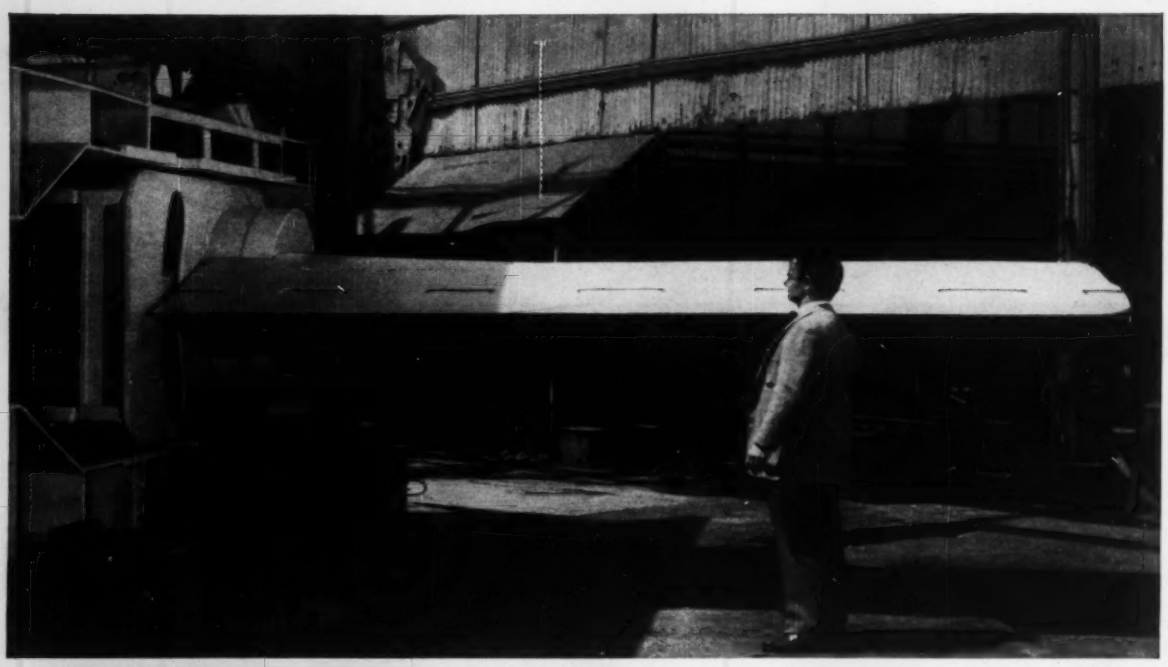

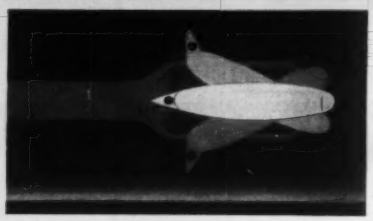

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PWR Nuclear Reactor Vessel Shell in Transit . . .

. . . from Chattanooga, Tenn., where it was built by Combustion Engineering, Inc., to site of America's first full-scale nuclear power station at Shippingport, Pa. Westinghouse Electric Corporation is designing Shippingport Power Station under contract with AEC. It will be operated by Duquesne Light Company and is scheduled to go into service in 1957. Maximum width of the 150-ton reactor vessel shell was 12 ft, 11 in., and maximum height was 17 ft, 7 in. above the rail. A special nine-car train, here shown crossing the Susquehanna River on the Rockville Bridge of the Pennsylvania Railroad, transported the vessel. The unusual halo effect, taken shortly after dusk from the rear of the train, was caused by the back headlight of the locomotive as the train entered a railroad yard (near Freeport, Pa.) for an overnight stop. (Photos by W. F. Mutschmann, *THE PENNSY*, and C. M. Zimmerman.)

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MECHANICAL ENGINEERING

George A. Stetson, *Editor Emeritus*
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Radioactive Strontium Fallout

CONSIDERABLE discussion has centered recently about the subject of radiation hazards from strontium 90 through fallout due to hydrogen bomb tests. One of the most serious problems involved concerning fallout is the extent of the radiation hazards from these tests—in particular, the genetic effects and the hazard from Sr 90, which when assimilated into the bones can cause blood changes and, in extreme cases, bone cancer. It may therefore be of interest to note what Willard F. Libby, Commissioner of the Atomic Energy Commission, had to say on current research findings on radioactive fallout. He spoke during the dedication ceremonies of the new building of the American Association for the Advancement of Science, in Washington, D. C.

For example, Dr. Libby explained that two years ago it was estimated that there were about 24 megatons of fission products stored in the stratosphere corresponding (if it were all deposited uniformly on the earth) to about 12 millicuries of Sr 90 per square mile and about the same amount of Cs 137.

At the end of 1955 the total deposition in the upper midwest of the United States was about 13 mc/mi^2 of Sr 90. In the spring of 1956 this total rose to about 16 mc/mi^2.

Between May 5 and mid-July of this year, Operation Redwing was conducted at the Eniwetok Proving Grounds in the Pacific. Particular attention was paid to the fallout problem in this Operation and a major effort was made to produce a megaton-range weapon with an inherently smaller amount of fallout for a given energy release. This effort was successful. In addition, considerable attention was paid to operational factors which would minimize world-wide fallout. Thus, the total deposition in the stratosphere during this Operation was held to a figure very considerably less than that present in the stratosphere before the Operation. In fact, it is estimated that the total stratospheric reservoir, counting all sources, is about the same as it was two years ago, i.e., about 12 mc/mi^2 of Sr 90 or the equivalent of 24 megatons of fission products calculated as a uniform world-wide distribution. During the past two years the additional depositions in the stratosphere have amounted to about 6 megatons equivalent of fission products total or 3 mc/mi^2 of Sr 90 or Cs 137. This appears to have compensated approximately for the 10 per cent per year of fallout and the 2.5 per cent per year of radioactive decay. In other words, the testing by all countries seems to have restored the stratospheric reservoir to approximately the 24-megaton value of two years ago.

The latitudinal tropospheric world-wide fallout, which is maximized by weapons of high yield which do not puncture into the stratosphere, is increasing. Several such weapons have been air-fired abroad in past months. This material descends rather rapidly but all the way around the world in the same general latitude as the firing site. Thus, though it is difficult to estimate, it appears that this amounts to perhaps 5 additional mc/mi^2 of Sr 90 and Cs 137 in the U. S. Adding to this about $^1/_2$ mc/mi^2 for the world-wide tropospheric fallout from the Redwing Operation and 1 mc/mi^2 for stratospheric fallout, it is estimated that a total of about 22 mc/mi^2 of Sr 90 is to be found at present in the soils of the midwestern U. S., and that perhaps 15 to 17 mc/mi^2 is the total to be expected for similar latitudes elsewhere in the world, the difference being due to our proximity to our own weapons-testing site in Nevada. These 22 mc/mi^2 of Sr 90 in the soil of the U. S. amount to about 0.040 MPC units in the top two inches of soil where most of the fallout is absorbed. (As used here, one MPC unit is 1 microcurie of radiostrontium per kilogram of calcium, or 1 microcurie per average adult human, the "maximum permissible concentration.") Therefore it seems reasonable to conclude, on the basis of a plausible mechanism for the transport of radiostrontium from the soil to humans, that the human body burden of Sr 90 might well be as high as 90 per cent of the concentration in the top soil on which people live; further evidence seems to indicate that this should be reduced to between 10 and 30 per cent. Therefore at the moment we would expect, assuming that no further weapons are fired, that the body burden for children born now in America eventually would amount to between 0.004 and 0.010 MPC units. Consideration of the rate of transfer from the stratosphere to the ground and the rate of radioactive decay indicates that the body burden to be anticipated 15 years from now probably will be substantially the same as it is today.

From the foregoing it is evident that the AEC is delving headlong into the problem of radiation hazards. And while not everyone agrees with its findings and its interpretations of the findings, the whole problem is being carefully studied. Since the hazards from strontium fallout affect the world in general, it seems to be an ideal problem for the United Nations to discuss and set the limits. A Scientific Committee on Effects of Atomic Radiation has already been set up by the U. N. and, with international co-operation, it is hoped that a happy solution to the question of "What should be the safe limits for the world's population?" will be answered.

Engineers—especially those in the field of nuclear engineering—should acquaint themselves with problems of health and radiation effects arising out of this new field. For in designing and developing both nuclear weapons and peaceful tools the engineer definitely will be contributing to changes in the environment which he and the general populace must inhabit.

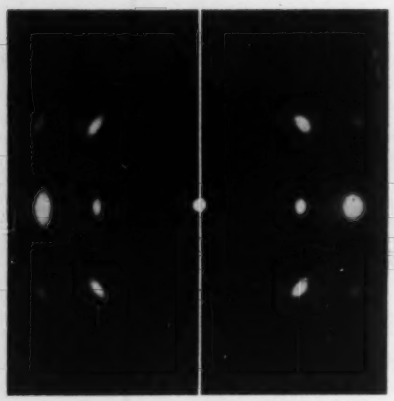
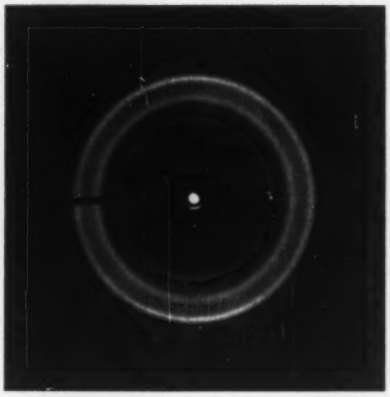


Fig. 1 *Left:* X-ray diffraction patterns of stretched polymers. *Left,* Hevea rubber; *right,* Coral rubber.

Fig. 2 *Right:* X-ray diffraction pattern of unstretched Coral polymer



PROPERTIES AND APPLICATIONS

Of Coral Rubber—a Cis-1,4 Polyisoprene[1]

This new polymer represents a possible answer to the need for a synthetic rubber suitable for heavy-duty truck and bus tires

By G. Alliger, J. M. Willis, W. A. Smith, and J. J. Allen

Chemical and Physical Research Laboratories,
Firestone Tire and Rubber Company, Akron, Ohio

SYNTHESIS by lithium catalysis of a polyisoprene having the essential molecular structure of natural rubber was described in a recent paper (1).[2] Discovery of this new polymer, Coral rubber, represents a possible answer to the need for a synthetic polymer suitable for heavy-duty truck and bus tires, a need never adequately met by general-purpose synthetic rubber (styrene-butadiene rubber). Even passenger tires manufactured for today's competitive market require substantial amounts of natural rubber. Many mechanical-goods items such as motor mounts, bushings, and industrial wheels are made entirely or partly of natural rubber. Coral rubber is a potential competitor of natural (Hevea) rubber for these applications.

Coral rubber has a microstructure similar to that of Hevea and yields an x-ray pattern similar to that of Hevea, both stretched and unstretched (Figs. 1 and 2). Coral rubber is also a high-molecular-weight polymer like Hevea. LTP (low-temperature polymer) differs in that it has less regularity in its structure and lower molecular weight.

[1] For more detailed discussion and complete data see *Rubber World*, vol. 134, no. 4, 1956, 549.

[2] Numbers in parentheses refer to the Bibliography at the end of the paper.

Based on a paper contributed by the Rubber and Plastics Division and presented at the Semi-Annual Meeting, Cleveland, Ohio, June 17–21, 1956, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

Properties of Coral Rubber

This paper discusses the properties of Coral rubber as they are related to those of natural rubber (Hevea) and certain synthetic polymers, particularly emulsion polyisoprenes and butadiene/styrene (LTP)[3] copolymers polymerized at 40–50 F.

Gum Stocks. Since Coral rubber is an elastomer of high molecular weight and regularity so that it crystallizes when stretched, it has the high-gum tensile strength characteristic of natural rubber. Coral rubber also has the same general reactivity with sulphur or sulphur-accelerator combinations which is possessed by Hevea, because its molecular structure is essentially that of Hevea.

Carbon-Black-Loaded Stocks. Coral/black stocks require sulphur concentrations slightly lower than are generally used in similar Hevea stocks. Accelerator requirements are about the same for both Hevea and Coral rubbers and less than for LTP. Coral and Hevea rubbers have good tensile strength at black levels as low as 10 parts per 100 of rubber (phr). On the other hand, LTP requires 30 phr of black for satisfactory tensile strength. Furthermore, Hevea and Coral retain a large proportion of their tensile strength at 212 F and 275 F even with low black loadings, but LTP retains very little strength ex-

[3] Designated GRS1500 during government operation of plants.

cept at high black loadings. More important, Coral, like Hevea, retains its elongation well at 212 F and 275 F, while LTP compounds become very short at these elevated temperatures.

Dynamic Properties. Properly mixed, Coral compounds were found to have the same dynamic properties as Hevea compounds if measured at equal black loadings. Low internal-friction and dynamic-modulus values mean low hysteretic loss and hence less heat build-up (2). The basic equality of Coral and Hevea with respect to dynamic properties is confirmed by the data in Fig. 3, which show the internal friction of Coral to be equal to Hevea and lower than LTP over a temperature range from 0 to 250 F. For these tests, all three polymers were compounded with 50 phr of high-abrasion furnace (HAF) black.

Heat build-up can be measured directly on the Fire-

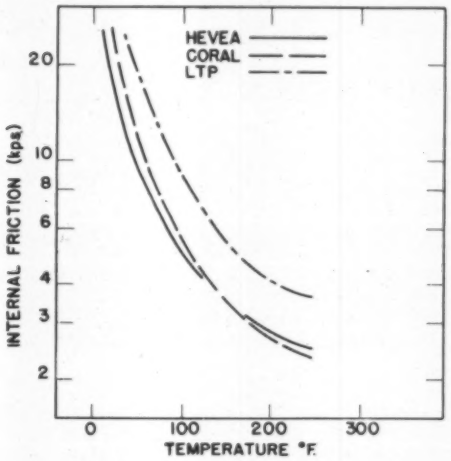


Fig. 3 Internal friction as a function of temperature (50 phr of HAF)

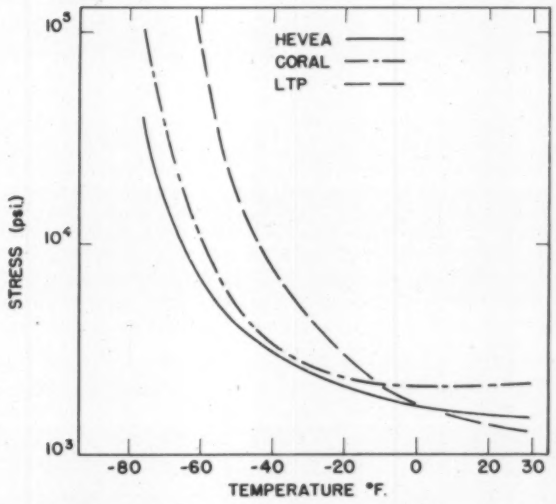


Fig. 4 Young's bending modulus of Coral vs Hevea vs LTP (50 phr of HAF)

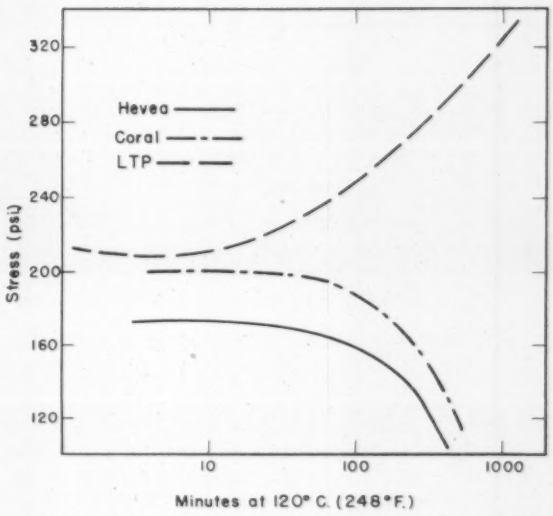


Fig. 5 Stress change on intermittent elongation (50 per cent) at 120 C (50 phr of HAF)

stone Shear Flexometer (3) both at constant force and constant amplitude. It was found that, under these conditions, the temperature rise for Coral is similar to that of Hevea for both conditions of test while that of LTP is much higher than for either polyisoprene.

Cold Resistance. Coral and Hevea rubber are about equal in cold properties, both being somewhat better than LTP in this respect. The Young's bending-modulus (4) curves, Fig. 4, show very strikingly the similarity of Coral and Hevea with respect to cold resistance.

Aging Properties. In general, Coral rubber has better resistance to accelerated oven or bomb-aging than Hevea. However, the oxygen-absorption rate (5) of Coral polymer was found to be similar to that of Hevea and higher than that of LTP. The results of intermittent stress-relaxation studies disclose an even more fundamental difference between Coral and Hevea, on the one hand, and LTP on the other (Fig. 5). The tendency of LTP to cross-link on aging, with a resultant increase in modulus, in contrast to the predominant chain scission with resulting stress decay which is characteristic of Hevea, has been pointed out by a number of investigators including Andrews, Tobolsky, and Hanson (6) and Shelton and Cox (7). As might be predicted from the stress relaxation or oxygen-absorption results, Hevea and Coral behave similarly on aging under various standard conditions as measured by the per cent change in tensile and elongation properties (Table 1).

Applications of Coral Rubber

As stated earlier, the bulk of natural rubber consumed by the tire industry is used in treads and bodies of heavy-duty tires. Body stocks for such tires particularly require natural rubber not only for adequate performance in service but for suitable building tack. Natural rubber has adequate green strength and tack required for proper tire construction while LTP does not. Early work on synthetic body stocks for truck tires led to the conclusion that low heat build-up and high strength at tire operating temperatures are essential for long tire life.

Table 1 Aging Resistance of Coral, Hevea, and LTP Compounds

(50 phr HAF black)

Property (Cure—60 min at 280 F)	Per cent of original property retained		
	Coral	Hevea	LTP
Oven aging—48 hr at 212 F			
Tensile at break	61	45	80
Elongation at break	62	55	49
Oven aging—14 days at 158 F			
Tensile at break	89	82	94
Elongation at break	78	80	65
Oxygen bomb—96 hr at 158 F			
Tensile at break	75	59	88
Elongation at break	86	87	82
After 80 hr O_2 absorption at 194 F			
Tensile at break	55	43	87
Elongation at break	62	55	59

It has been impossible, heretofore, to combine both of these properties in the same synthetic construction. Coral rubber is the first synthetic rubber, suitable for tires, to give promise of meeting both of these requirements. It should be added that, to a degree, the tread stocks in heavy-duty tires should meet these requirements also. Yet it must be emphasized that heat build-up and good hot tensile strength are not the only properties important to good truck-body performance. Cohesive quality and green strength for building quality affect tire performance to a greater or lesser extent (8).

Coral Rubber in Tire-Body Compounds. Properties of Coral, Hevea, and LTP rubber compounded in a typical body-stock formulation are shown in Table 2. It will be

Table 2 Tire-Body Compounds of Coral, Hevea, and LTP

(Black, 25 phr; Cured 45 min at 280 F)

	Coral	Hevea	LTP
Normal			
300 per cent modulus, psi	600	600	425
Tensile strength, psi	3825	3675	3050
Elongation, per cent	700	680	780
At 212 F			
Tensile, psi	1900	1825	575
Elongation, per cent	650	660	370
Dynamic properties			
Internal friction, kgps	0.6	0.6	2.8
Dynamic modulus, psi	71	73	109

noted that the hysteresis properties for Coral are low and equal to those of the Hevea control. Also the hot tensile strength of the Coral stock is excellent, being much better than that of the LTP compound and very slightly better than that of the Hevea control. Coral stocks of this type can be calendered without difficulty in sheets or on tire fabric. Coral body plies can be built into tires without using cements, indicating that Coral rubber has adequate building tack.

Coral Tread Compounds. Low heat build-up and good strength at high temperatures are important properties of tread compounds as well as of body stocks. The data of Table 3 support the conclusion that Coral rubber approaches or equals the quality of natural rubber with respect to tensile strength, hot tensile strength, and hysteretic loss.

Tire Tests. To determine whether the low hysteresis of Coral rubber stocks actually means low heat build-up in tires, two truck tires, one Coral throughout and a Hevea

Table 3 Coral vs Hevea vs LTP—50 HAF Tread Stock

	Coral	Hevea	LTP
	Mooney scorch at 250 F (9)		
T_5 (Min to 1 point rise)	40	27.5	39
T_c (Min to 10 point rise)	40	40	40
	Properties cured 60 min at 280 F		
300 per cent modulus, psi	1900	1950	2025
Tensile, psi	3825	4150	3975
Elongation, per cent	550	540	510
	Shore A hardness		
	63	61	65
	Forced vibrator at 100 C (2)		
Dynamic modulus, psi	191	187	198
Static modulus, psi	163	150	139
Internal friction, kgps	2.6	2.7	3.7
	Firestone flexometer (10)		
Running temperature, deg F	250	250	275
Blowout time, min	24.5	18	105
	Properties at 212 F		
Tensile, psi	2200	2430	1330
Elongation, per cent	525	580	280
	Properties at 275 F		
Tensile, psi	1275	1650	925
Elongation, per cent	400	650	215
	Ring tear—lb/in.		
At 212 F	386	569	267
At 275 F	325	395	244
	Crack growth (11)		
0.01 in. per hr			
Normal	0.4	0.3	18.7
Aged 5 hr air bomb	17.5	16.5	143
	Normal crack initiation at 200 F (11)		
Number of cracks			
Large	2	0	1
Medium	1	2	0
Small	2	9	0
Total	5	11	1
Rating (1 = Best)	2	3	1
	Compression set (22 hr—70 C—30 per cent deflection)		
Per cent set	8.42	9.72	7.82
	Permanent set (5 hr at 225 F at 50 per cent elongation)		
Per cent set	25	31	27
	Aged 2 days at 212 F		
300 per cent modulus, psi	2100	1875	
Tensile, psi	2300	1875	3175
Elongation, per cent	340	300	250
	Aged 14 days at 158 F		
300 per cent modulus, psi	2350	2425	3425
Tensile, psi	3425	3425	3725
Elongation, per cent	430	430	330
	Aged 96 hr air bomb		
300 per cent modulus, psi	1800	1600	2550
Tensile, psi	2800	2450	3500
Elongation, per cent	470	470	420

control were placed on test on an indoor wheel at the same time. Starting at 35 mph, the speed was increased at regular intervals and the contained-air temperature measured throughout the test. The temperatures for the two tires were equal within experimental error throughout the whole course of the experiment (Fig. 6).

Besides this test, measurement of shoulder and contained-air temperatures during fleet tests also showed Coral tires to run as cool as those of natural rubber, Table 4.

Table 4 Temperature Measurements, Coral and Hevea Tires

(Sizes 9.00-20)

(Firestone Test Fleet—Tractor Rears)

	Contained-air temp, deg F		Shoulder temp, deg F	
	Left rear	Right rear	Left rear	Right rear
Hevea	170	177	191	200
Coral	170	185	190	202

Furthermore, although tires of 100 per cent LTP or of largely LTP construction tend to fail from tread or ply separation, no Coral tire tested to date (although a total of 500,000 test miles have been accumulated on Coral truck tires) has failed for either of these reasons. Tests indicate that the body durability of Coral truck tires equals tires of natural rubber construction (Fig. 7).

Both Coral passenger and truck tires having wear resistance substantially equal to that of Hevea tires have been built and tested, Table 5.

Table 5 Coral Truck Tire Tests

(Commercial Highway Service—Tractor Rears, Dual)

Size—9.00-20 Overload—Variable
Season—Year round Inflation—65 psi

Construction	Average mileage	Average skid loss	Comment
Coral body stocks Hevea treads	39560	67%	Removed—No failures
Coral body stocks Coral treads	34280	70%	On test—No failures

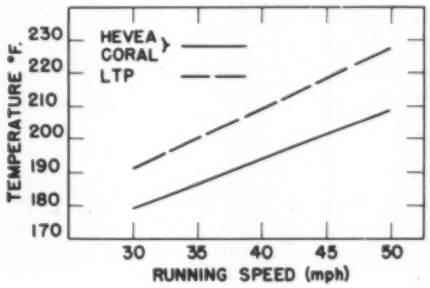


Fig. 6 Contained-air temperatures of 9.00-20 truck tires running on indoor wheel at 125 per cent of rated load

Furthermore, the superior laboratory-crack-initiation resistance and cut-growth resistance of Coral rubber are borne out by tire tests (Fig. 8) which show Coral passenger tires to be more crack-resistant than natural rubber.

Coral rubber has also been successfully applied in the bodies of large-size truck and prime-mover tires used in operations across rough terrain.

Coral Motor Mounting Compounds. Since Schmuckal (12) has shown that automobile-motor mountings operate under conditions of constant-energy input rather than constant force, the values of temperature rise for Coral, Hevea, and LTP stocks (with 25 phr of HAF black) against energy input were measured in the Firestone Shear Flexometer (3). The Hevea and Coral curves are almost superimposed. LTP, on the other hand, showed a greater temperature rise than Coral or Hevea, particularly at higher energy inputs (Fig. 9).

Measurement of blowout resistance (10) of these same compounds indicated Coral to be superior either to Hevea or to LTP. Shore hardness was equal for all three compounds, Table 6.

Table 6 Coral, Hevea, and LTP in a Motor Mounting Compound[a]

(50 Min at 280 F)

	Coral	Hevea	LTP
Dynamic modulus, psi (2)	79	102	113
Internal friction, kgps (2)	0.5	0.7	2.0
Shore "A" hardness	57	58	57
Per cent deflection (10) (500 lb load)	46.7	40.7	46.7[b]
Blowout time (10), min.	174	125	17[b]

[a] 25 phr HAF black.
[b] Cure—75 min at 280 F.

These data suggest that Coral stocks could be prepared which would perform satisfactorily in motor mountings.

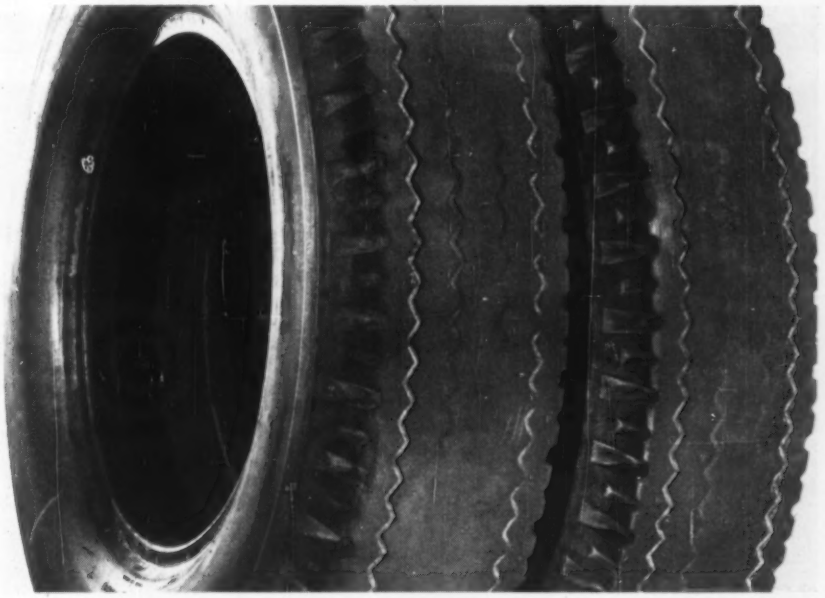


Fig. 7 9.00-20 truck tires after 43,350 miles of commercial service on tractor rear wheels. *Left,* Coral rubber; *right,* natural rubber.

Fig. 8 Crack resistance of Coral and Hevea treads on 8.00-15 passenger tires after 12,000 miles. *Left,* Coral rubber, no cracking; *right,* Hevea, cracking.

Acknowledgment

The authors wish to express their appreciation to Dr. F. W. Stavely for his interest and suggestions and to the Firestone Tire and Rubber Company for permission to publish this work. They also wish to thank Messrs. George L. Hall and Floyd S. Conant for their help in interpreting the data and for obtaining the stress-relaxation and cold shear recovery data.

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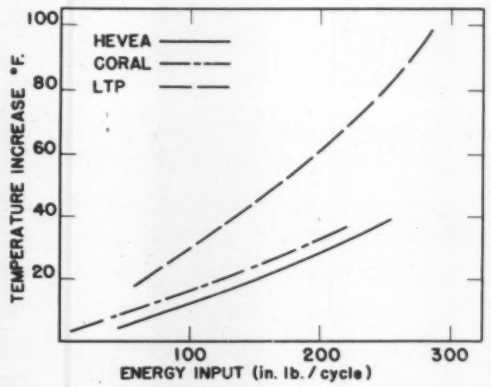

Fig. 9 Heat build-up as a function of energy input (Firestone Shear Flexometer)

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The Importance of Registration in Improving the Status of Engineers

By John J. Uicker[1]

The engineering college graduate might ask, "What Is Registration?" and "How does Registration improve the status of engineers?" Registration may be defined as the approval, granted by a state, for an individual to practice professional engineering on his own responsibility. The answer to the second question is more involved and will develop the importance of Registration in improving the status of engineers.

To BECOME a Registered Professional Engineer, a person must have a proper background of education, practical experience, and character qualifications.

The State Laws do not require that a candidate must have been graduated from an approved college of engineering. They do require that he must have obtained the equivalent education. This is tested carefully in the examination procedures used in most states.

Most of the State Laws require the State Board of Registration to inquire into the training of the applicant in engineering fundamentals subjects. This is done usually by means of written examinations. About 80 per cent of the states allow the engineering fundamentals examinations to be written by applicants at any time after the baccalaureate degree is conferred. The passing of this examination brings recognition from the State that this candidate for registration is now an "Engineer-in-Training." There are no legal rights to practice attached to this recognition, but the candidate has a credit in fundamental subject matter and will not have to write that examination later when he has fulfilled the necessary experience requirements. These same states give a fundamentals of engineering examination also to those who have the minimum necessary experience to be registered and who are not Engineers-in-Training. Most of the states give this latter examination, which is a written examination.

The practical experience requirement is generally eight years of acceptable engineering experience. A degree in engineering from an ECPD approved college of engineering usually will bring the additional practical requirement down to four years. This experience is defined as that engineering work where the individual adds some of the engineering thinking to the job, such as making minor decisions on design features, specifications, methods of procedure, and so on. He does not have to be responsible for the job. He does have to contribute ideas based upon experience and engineering fundamentals. This requirement is tested in two ways: By written or oral examinations, and by personal testimony from those who are familiar with his engineering work.

Other educational qualifications usually checked by examination are English, report writing, and ethics. Here again the examination is usually a written one. In some states, this is made a part of the Engineer-in-Training examination. In others this ground is not covered until the candidate has the minimum necessary experience.

Character references are required. These are consulted to determine the suitability of the candidate for professional recognition.

All of these factors taken together form a very comprehensive and quite dependable measurement of the competence of the individual to practice professional engineering. This stature is possible of attainment only through years of practice of the profession of engineering in a subordinate capacity with constant devotion to personal development in continued education as well as experience.

Early Registration Urged

As this article revolves around the status of engineers, it becomes necessary to consider how registration can and does aid in their improvement.

If registration is considered an objective to be attained by the young engineer, he should strive to accomplish it as soon as possible since his future depends upon it. Several benefits in terms of personal growth will be experienced:

It will provide a powerful stimulus to worth-while activities on his part which might otherwise be delayed too long or neglected.

1 He will keep a watchful eye on the nature and breadth of the experience which he gains in his work from the point of view of his growth as an engineer.

2 He will carry on further general study in engineering fundamentals, at least until he has passed that portion of the State Board Examinations.

3 He will study additional material such as: engineering law, ethics, English, and report writing, all of which form a part of the professional examinations.

This continuation of study and personal growth for the development of the engineer after his graduation is in line with the principles laid down by Dr. Wickenden in "The Second Mile" and since subscribed to and promoted by the ECPD.

Registration of engineers establishes them as a group apart. It puts them in a recognized professional category which they did not formerly enjoy. Engineers have a responsibility as professional people to devote more attention to doing a better job of serving the public and then can merit greater confidence by the public. Such recognition of the efforts and accomplish-

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ments which have been made by the professional engineers now and formerly engaged in practice gives the young engineer a certain standing which has been earned for him by the profession. This automatically improves his status.

The development of any true professional engineer in terms of his stature with its responsibilities to his profession and to society requires both professional engineering experience on the part of the man and assistance in his professional growth on the part of the profession.

The latter of these two factors is much better recognized by some other professions. Thus far, in the engineering profession, the proper development of the young man has been left too much to the individual. Engineers have not, as yet, assumed the full responsibility for this growth which the public has a right to expect from any true profession. Engineers have not concerned themselves sufficiently with the need to provide for their successors to serve the public.

Industry's Responsibility

Of late, industry is becoming aware of its responsibility in the growth and training of professional engineers. While eventually this will be a major factor in the improvement of the status of engineers, it has not yet had much significance. Until very recently, industrial concerns have, with rare exceptions, taken the attitude that they can pay only for immediate productivity. This has caused a considerable pressure toward immediate specialization. Such specialization so early in a young engineer's career causes a trend away from professional stature, and tends to defeat eventual registration. The pattern is changing very slowly as industrialists become aware of this responsibility. Meanwhile, the young engineer must watch his own progress to see to it that he acquires the necessary breadth of development.

Professional Societies' Responsibility

Until recent years, the professional societies generally have been concerned with the development of technical knowledge more than with the growth of people. This is much in evidence when one considers the limited activity which has been developed in civic affairs and on the effort toward the growth and integration of the training phases of the profession. Examples of this are numerous and need not be covered here. What is important to this consideration is that the societies in general have not stressed registration sufficiently.

The engineering profession and its professional societies have not been successful completely in helping the public in its present confusion over the concept of "What Is an Engineer?" when the examples vary from the truly professional to the ridiculously unprofessional. Professional registration and the advancement of it by the engineering societies should eliminate the present sad state of affairs. This certainly will improve the status of engineers.

A word of caution must be added. Registration should not be considered as an end point or goal in itself. It is rather the beginning of possible full participation in professional effort.

The aspirations of the engineering college graduate should be to become a professional engineer and to identify himself in the company of those who are qualified to practice in this profession. To acquire this privilege, he must become a professional person in his thinking and his actions. Thus, professional registration offers to the young engineer a goal of personal development and an opportunity to serve mankind in a more responsible and more privileged manner than that enjoyed by others not so qualified.

The Council of ASME, on April 6, 1956, adopted the policy which endorses and supports the registration of professional engineers as being in the best interests of the engineering profession and the general public. In support of this policy, ASME:

1 Approves in principle the Model Law and pledges to co-operate with other sponsoring groups in its revision, subject to approval by the Council.

2 Offers its facilities to assist in the appropriate revision or modification of registration acts in States where responsible organizations request such assistance.

3 Supports financially the activities of the National Council of State Boards of Engineering Examiners and gives advice and assistance to the Council when requested.

4 Recommends that there be no discrimination by implication, omission, or direction as to the form of business organization (individuals, partnerships, corporations, or others) under which the practice of engineering is conducted provided that the person or persons in responsible charge of such practice be legally registered professional engineers.

5 Recommends that each Section appoint a standing committee known as the Registration Committee to co-operate with the State Registration Board and the Section Program Committee in the dissemination of information concerning registration.

6 Recommends that each Section devote some time in a Section Meeting each year to the subject of engineering registration where, if possible, a member of the State Registration Board would address them.

7 Recommends that, in States in which written examinations are required of applicants for registration, Sections co-operate with other groups in sponsoring refresher courses.

8 Recommends that each Student Section devote a session to engineering registration where, if possible, a member of the State Registration Board or a prominent registered professional engineer would address them, placing special emphasis on the purpose of registration, the standards required for registration, the Engineer-in-Training program, and the procedure for applying for registration.

The Failure of a Welded Drying Drum by Caustic Embrittlement

Welded drying drums of a type widely used in the paper industry may be operating under dangerous conditions

By George Sines[1] and E. C. McLean[2]

FAILURE of welded pressure vessels by caustic embrittlement is an uncommon occurrence (1).[3] However, before the introduction of welded joints, caustic embrittlement caused the failure of the riveted joints of many pressure vessels (2). It was a common cause of failure because boiler water is usually treated to be slightly alkaline to prevent the formation of rust, and riveted joints often have slight leaks so that evaporation of the water seeping through the joints builds up the alkaline concentration of the residual solution in the cracks between the joined plates.

The inspection of the failure of the welded drum illustrated here indicates that under certain conditions of operation an unsuspected concentration of alkalinity can occur in a welded pressure vessel. Welded drying drums similar to the one which exploded have come into wide use during the past five years in the paper industry, and it is imperative that the condition which led to this failure be understood so that catastrophies can be avoided in the future.

Description of the Drum and Conditions of Operation

The preheater drum was a cylindrical container 3 ft in diameter and 8 ft long. This drum rotated about its axis in a horizontal position and served to dry paper which passed around it in an arc of approximately 270 deg. The drum contained saturated steam and condensate at 175 psi (377 F). The steam was introduced, and the condensate removed, through fittings on the axis of rotation. The condensate was withdrawn by a pipe which reached down into the drum and extended to within one inch of the bottom.

The boiler water was treated by the zeolite process, and the return lines were amine-treated, which is common practice.

The only appreciable stress on the drum was from the internal pressure. The only other applied force was the tension of the paper which passed over it, and this must have been small. The stresses from misalignment of the bearings on which the drum rotated must also have been small because (*a*) only a very small torque was available to turn the drum, and (*b*) the pedestals supporting the bearings were fastened to the base by only two $^{5}/_{8}$-in. bolts. These bolts surely would have failed before any appreciable stress could have been applied to the drum by bearing misalignment.

The drum was not continuously heated but was usually shut down for a part of each day. It had been in service six years.

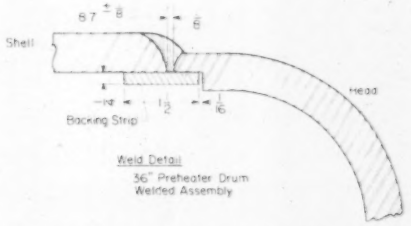

Fig. 1 Weld detail of 36-in. preheater drum

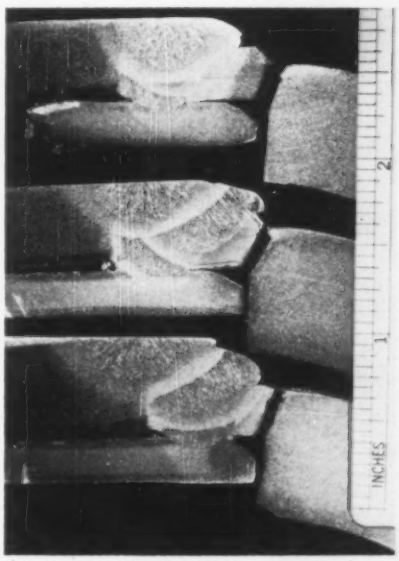

Fig. 2 Micrographs of the fractured section at three different places on the periphery. *Top left,* end of the drum shell; *lower left,* backing strip; *right,* head.

The Failure

One head of the drum blew off, breaking the bearing pedestals and blowing out the adjacent brick wall of the building. Three men were killed.

The section in which the failure occurred can be identified on the detailed drawing of the head weld, Fig. 1.

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[2] Consulting Industrial Engineer, Chicago, Ill.

[3] Numbers in parentheses refer to the Bibliography at the end of the paper.

Fig. 2 presents photographs of sections transverse to the fractured surface. It can be seen that the fracture took place in the head, starting at the sharp machined corner on the inside diameter of the knuckle where it had been enlarged to the internal diameter of the drum in order to accommodate the backing strip. Fig. 3 shows the fractured surface. Region A is not a fractured surface but the machined face where the knuckle thickness was reduced to match the internal diameter of the shell. The sharp re-entrant corner separates Region A from the fractured Region B. Region B of the fracture has a very brittle appearance and has a black-oxide coating over much of it. Region C, which is only about $^1/_{16}$ in. thick, has a mixed brittle and ductile appearance with some jagged torn edges near the exterior surface. It is assumed that it was across Region C that the final catastrophic failure occurred.

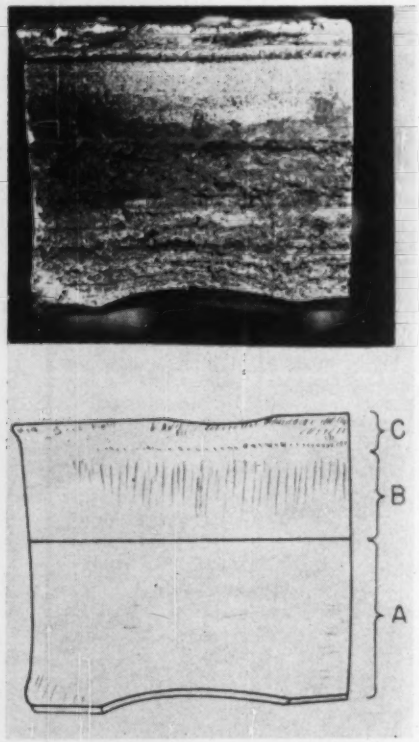

Fig. 3 Surface of the fracture: (A) Machined face where the head is reduced to thinner section; (B) progressive fracture which shows some black iron oxide; and (C) final catastrophic fracture region. Magnification $\times 3^1/_2$.

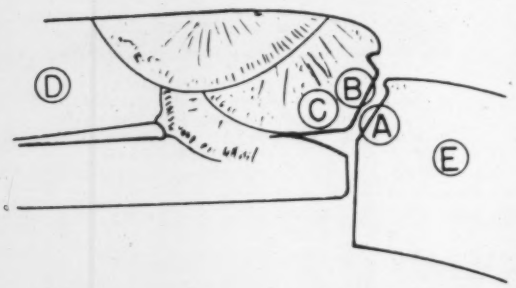

Fig. 4 Identification of areas micrographed on Specimen No. 2: (A) Region on head side adjacent to the fracture; (B) region on shell side adjacent to the fracture; (C) head metal in the weld-affected zone; (D) shell metal in a region at a distance from the weld; and (E) head metal in a region at a distance from the weld.

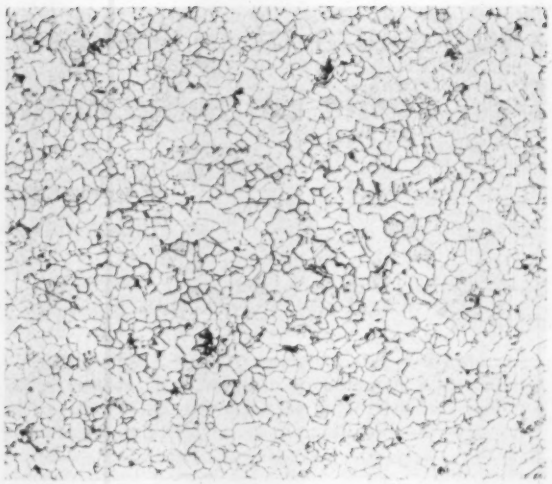

Fig. 5 Micrograph of the shell metal in a region at a distance from the weld (Area D of Fig. 4). Nital etch. Magnification $\times 100$.

Examination of the Steel

The micrographic examination of the shell metal, Fig. 5, in a region at a distance from the weld, indicates that it is an annealed low-carbon steel. The micrograph of the steel in the head, at a distance removed from the weld, Fig. 6, shows that it is in a normalized condition and that it is a higher-carbon steel than the shell. The chemical analysis of the head metal is: Carbon, 0.29; manganese, 0.38; phosphorus, 0.018; sulphur, 0.055; silicon, 0.03; chromium, 0.05; nickel, 0.07; molybdenum, 0.01; vanadium, —; copper, 0.20; and aluminum, 0.002.

The micrograph of the head metal adjacent to the weld, Fig. 7, shows the typical structure of a welded area which has not been normalized subsequent to welding. Examination of the regions near to the fracture, Figs. 8 and 9, shows that the fracture progressed along the edge of the heat-affected region.

This chemical and micrographic evidence reveals nothing unusual about the steel used or the weld zone. The drum was not normalized after welding, but this is not required by the ASME Code for Unfired Pressure Vessels for vessels of this description.

The Brittle Condition of the Metal

The samples of metal adjacent to the fracture were removed by first making two parallel saw cuts approximately an inch apart and about two inches long perpendicular to the fracture. On the outside surface of the drumhead, at the end of the saw cuts, a notch about

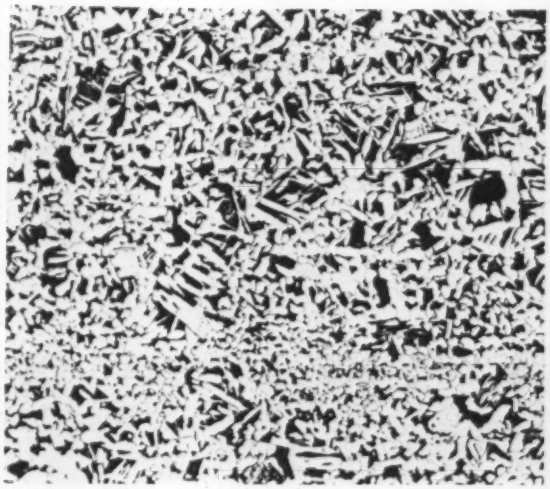

Fig. 6 Micrograph of the head metal in a region at a distance from the weld (Area E of Fig. 4). Nital etch. Magnification ×100.

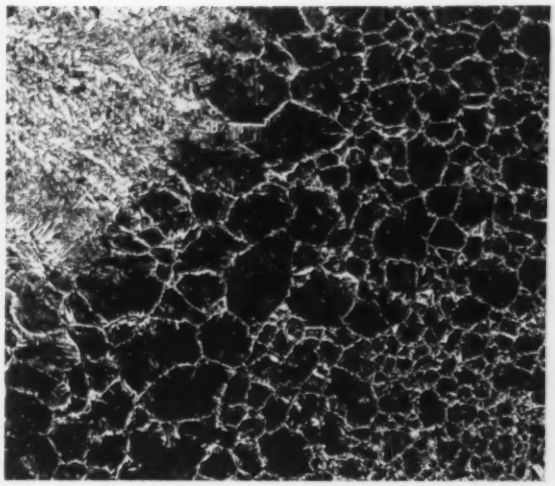

Fig. 7 Micrograph of the head metal in the region strongly affected by the welding heat (Area C of Fig. 4). Nital etch. Magnification ×100.

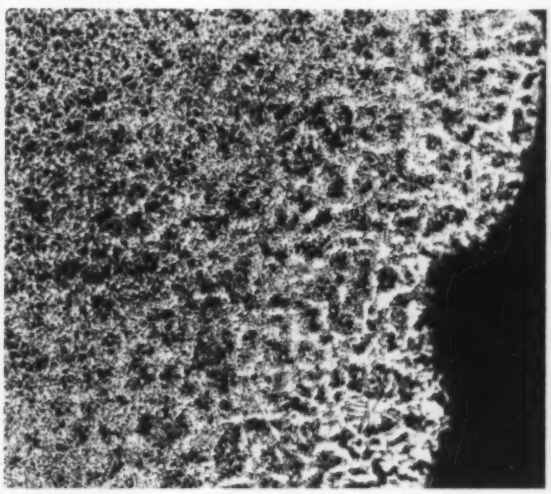

Fig. 8 Micrograph of the head metal in the region adjacent to the fracture on the shell side (Area B of Fig. 4). Nital etch. Magnification ×100.

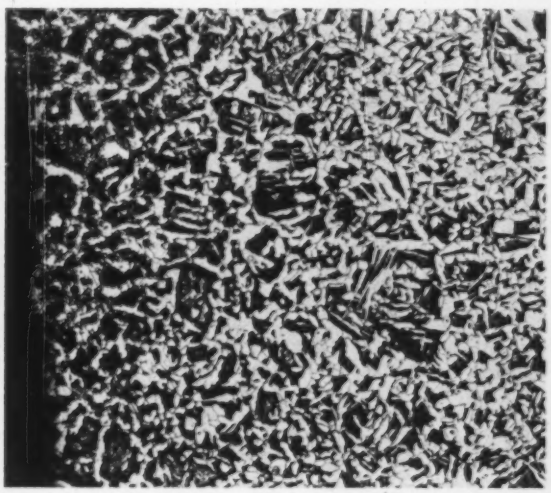

Fig. 9 Micrograph of head metal in the region adjacent to the fracture (head side). (Area A of Fig. 4). Nital etch. Magnification ×100.

$^1/_{16}$ in. deep was chiseled normal to the cuts. The sample broke off at the notch from one blow of a hammer. This fracture surface, Fig. 10, has a very brittle appearance. A normalized 0.29 carbon steel should not be expected to fracture in such a brittle fashion. The samples broke off from the shell, which was made of annealed low-carbon steel, in an equally brittle way.

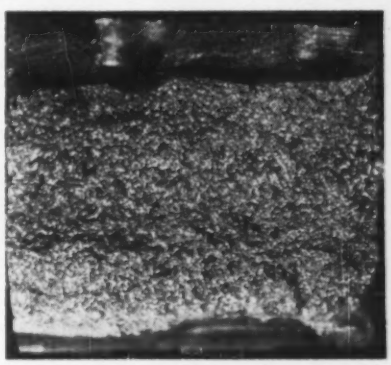

Fig. 10 Brittle-fractured surface of the head metal made in removing specimen. Magnification ×3.

The Metallographic Examination of the Metal

Examination of the structure reveals several interesting regions, which are identified in Figs. 11 and 12.

In Fig. 11 a band about $^1/_{16}$ in. in width can be seen to extend along the inner surface of the shell beneath the backing strip. Although etched with nital, this band

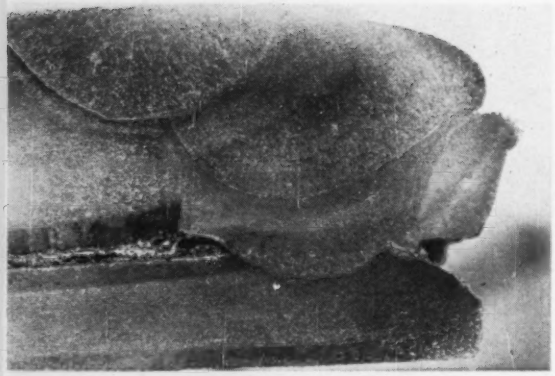

Fig. 11 Micrograph to identify the regions having cracks which contain black iron oxide. Nital etch. Magnification ×6.

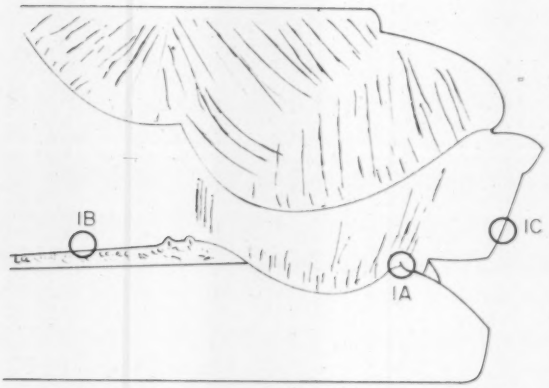

Fig. 12 Sketch of micrograph to identify regions having cracks which contain black iron oxide

retained a shiny appearance. Also, while it is not shown in the photograph, this region is not only beneath the backing strip but extends beyond it along the inner surface of the shell. A micrograph of this area, identified as 1B in Fig. 12, is presented in Fig. 13. When the appearance of this region is compared with that which is farther away from the surface, Fig. 5, a striking difference is apparent. It has large columnar grains whose boundaries are normal to the surface. A chemical analysis of this region showed that the carbon content was only 0.05 per cent compared to 0.10 per cent for the shell plate. Evidently some action has decarburized the steel on the inner surface of the shell.

In Fig. 13 notice that cracks filled with black oxide have progressed between several grain boundaries normal to the surface. The same kind of black oxide appears on the surface of the fracture, identified as region B of Fig. 3, and it also can be seen on the edge of the fracture shown in Fig. 14. At several places along the fracture surface, cracks filled with black oxide branch out, Fig. 15.

Caustic Embrittlement

Let us compare this evidence with the characteristics of the fracture commonly ascribed to caustic embrittlement (2). Features of this type of failure are: (*a*) A progressive intergranular fracture which has a brittle appearance, (*b*) the presence of black iron oxide (Fe_3O_4), and (*c*) the presence of decarburized regions (sometimes).

The following conditions must exist simultaneously at one place for caustic embrittlement to occur: (*a*) Water in contact with the steel, (*b*) the water sufficiently basic, and (*c*) the steel under tensile stress.

High temperature accelerates the process. The presence of small amounts of certain impurities in the water can hasten (or retard) the process.

A better understanding of this action may be had through a brief review of the theory. Although there appears to be some dispute about the mechanism of caustic embrittlement, the following ideas have at least partial acceptance (2). The reaction of water with iron to form black iron oxide (Fe_3O_4) proceeds at an appreciable rate if the conditions mentioned above are present. The reaction proceeds along the grain boundaries, forming a crack filled with the oxide. The crack continues to grow because its tip is a severe stress concentration which causes the rate of formation of oxide to be the greatest at that point. The crack slowly progresses across the section until the stress in the remaining area becomes so great that a rupture occurs.

The other product of the reaction is atomic hydrogen which diffuses into the metal. The atomic hydrogen has two effects: (*a*) Its presence, or possibly its precipitation as molecular hydrogen at crystal defects, embrittles the iron, and (*b*) the atomic hydrogen reacts near the surface with carbon to form methane. The continual diffusion of carbon to the surface and its escape in the form of methane from the free surface decarburizes the iron.

Conclusions

When the evidence taken from this drying drum which failed is compared to the known characteristics of caustic embrittlement, it seems very likely that caustic embrittlement was the cause of the failure. The presence of hydrogen resulting from a caustic environment was revealed by the brittle manner in which the sample could be broken out of the drum. The presence of the columnar decarburized layer on the inside of the shell may also indicate a caustic environment during service, although it is possible that decarburization occurred during the annealing of the plate. One reason to believe that it may have occurred during service is that there was sufficient time at the operating temperature for the carbon to diffuse out by volume diffusion, and the diffusion would be aided by the grain boundaries which grew normal to the surface. Another reason is that low-temperature decarburization favors "columnarization" (3).

There may also have been concentration of the caustic in the narrow space between the shell and backing strip and also between the edge of the backing strip and head by a process called "crevice concentration" (4).

The region at which the fracture occurred shows little decarburization, but here the stresses were much higher, and the crack may have progressed too rapidly to permit it. Also the concentration of the caustic may have been less in this region, or the normalized structure may be more resistant to decarburization.

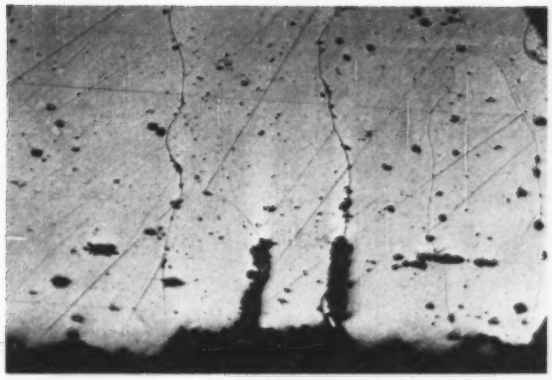

Fig. 13 Decarburized region on the inside of the shell beneath the backing strip (Area 1B of Fig. 12). Nital etch. Magnification ×150.

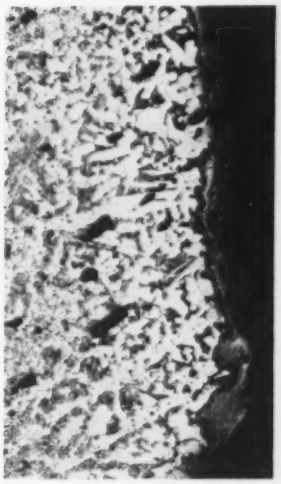

Fig. 14 Edge of the fracture which shows black-oxide layer (Area 1C of Fig. 12). Nital etch. Magnification ×150.

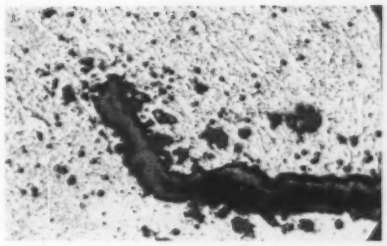

Fig. 15 A crack containing black oxide (Area 1A of Fig. 12). Nital etch. Magnification ×150.

The failure was accelerated by high stresses arising from: (*a*) A severe stress concentration at the sharp re-entrant corner which had been machined in the head; (*b*) bending stresses caused by the drastic transition from a thick drumhead to the much-reduced section at the knuckle; and (*c*) residual stresses which are present near weld heads. The nominal stress at the joint was slightly above that required by the Boiler Code in force at the time of construction.[4] For the 55,000-psi steel which was specified and the thickness of the head near the joint, which can be measured on the cross section, Fig. 2, to be 0.25 in., the safety factor is calculated to be 4.4 instead of the required 5.0. After this explosion, investigations were made of similar drums by Mr. G. Gearson, Chief Inspector, City of Chicago Department for Boiler Inspection. Several cases were discovered where cracks had started but had not yet reached a depth where catastrophic failure was imminent. His department recommended the temporary measure of cutting "weep holes" across the suspected regions as an emergency measure until replacement drums arrive. These are narrow slots cut across the joints and extending to a depth equal to about one half the thickness of the boiler plate. If a crack grows until it reaches the weep hole, the escape of steam will reveal its presence.

It is difficult to predict how soon the failure would have occurred if the sharp re-entrant corner had not been cut in the head. Notice that the cracks in the shell, Figs. 11, 12, and 13, have progressed less than 0.007 in. in the same time it took for complete failure to occur at the notch. However, a hazard exists even without the cracks if the steel is embrittled by the hydrogen, because an accidental blow might cause the drum to shatter.

The evidence indicates that the water in the drum was very caustic. Some mechanism must be present in the operation of the drum to cause this. The reasons for this concentration should be given careful study because some precaution may be discovered to prevent it.

The method which was used to heat the drum that exploded is a very convenient way to heat a drier drum, and it is hoped that the use of more expensive materials to resist the caustic environment, or the use of a less convenient method of heating, can be avoided.

At the present time it appears that a dangerous situation may be prevalent in the paper industry and perhaps in others which use similar equipment. Steps are now being taken to determine the extent of the hazard.

[4] The external offset at the attachment of the head to the shell (as shown in Fig. 2) is within the limit specified in the 1946 Code for Unfired Pressure Vessels, Section U72(d), which was in force at the time of the construction. The internal sharp corner, the point at which the disastrous failure occurred, is probably not covered by this paragraph because it occurs at a distance away from the joint and, therefore, might be considered not to be an excessive offset. Section U72(e) does not state the manner in which the plate should be reduced in thickness so that the sharp re-entrant corner may be permissible. However, such an abrupt change in thickness is explicitly forbidden by Section UW-9 of the present Code: "A tapered transition section having a length not less than four times the offset between the adjacent plate surface, as shown in Fig. UW9, shall be provided at joints between plates that differ in thickness by more than one fourth of the thickness of the thinner plate or by more than $^1/_8$ in. . . ."

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Reducing Power Consumption in Hydraulic Circuits

How reductions in power consumption were accomplished in a new fork-lift truck design

By Oswald S. Carliss, Mem. ASME

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The Yale & Towne Manufacturing Company,
Philadelphia, Pa.

THE problem of reducing power consumption through the reduction of power losses in hydraulic systems is extremely important to all hydraulic engineers. It is particularly significant to the designers of battery-powered fork-lift trucks who must work with a finite amount of power. The trend in modern materials handling is to move more material per hour, with the most compact truck available. The use of higher travel and lift speeds, to accomplish this end, means greater demands for power, more work from the same amount of total power.

This paper is devoted to a discussion of some studies of the hydraulic-system components of a recently designed 4000-lb rated-capacity fork-lift truck, Fig. 1, and the improvements in power consumption obtained as a result of these studies.

Power Consumption Analyzed

Careful design of the traction unit—from the motor and its controls through the gearing to the rubber tires—has done much to reduce traction power losses to a minimum. Studies of current draw during the normal operation of a truck were then made. Using continuous recording ammeters it was possible to record the current draw for the drive and hydraulic-circuit motors separately during actual operation of the truck. A sample of the chart obtained during this testing is shown in Fig. 2.

Power consumption for hoisting from battery to load may be divided into the following categories: Losses in the wiring and connectors, motor, pump, pump lines, control valve, cylinder lines, flow control valve, hydraulic cylinder, and lifting chain and rollers.

Power consumption for the other common function—tilting—and for the operation of hydraulic attachments may be analyzed in a similar manner.

Lifting Speed Increased

In the course of the development of this new truck it was decided to increase the lifting speed. In order to accomplish this a smaller-diameter hoisting cylinder was used, rather than a higher-volume pump. This decision was made after a careful study of the space available for cylinder in the hoisting system and for a reservoir in the body of the truck. We found that the upper limit of pressure was in the neighborhood of 2000 psi based on commercially available components. The relief-valve setting was finally established at 1500 psi.

Based on a paper contributed jointly by the Hydraulic and Machine Design Divisions and presented at the Semi-Annual Meeting, Cleveland, Ohio, June 17–21, 1956, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

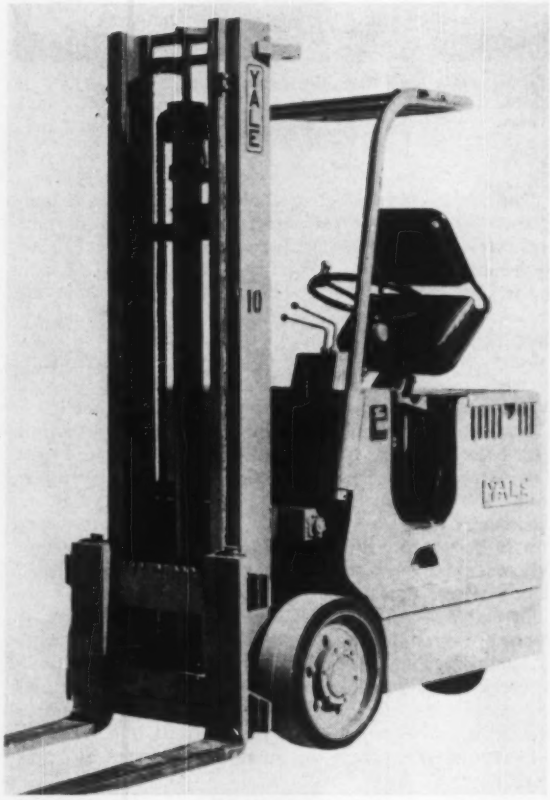


Fig. 1 Yale & Towne Manufacturing Company model K51AT-4024W 4000-lb electric fork-lift truck

The mechanical friction of the load carriage and other hoisting-system elements is held to a minimum by using guide rollers having antifriction bearings. An elementary comparison of the hoisting systems of the original model and of the newly designed model is shown in Fig. 3.

Determination of Power Losses

A graph of the measured power losses for the redesigned 4000-lb-rated-capacity truck is shown in Fig. 4.

Electrical losses were determined in the conventional manner using voltmeters and ammeters inserted at the desired reading points. Hydraulic losses were determined primarily on the basis of pressure drop. Meas-

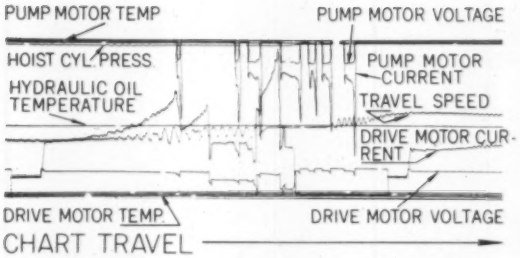


Fig. 2 Oscillograph recording of typical electric-truck operation made on test truck

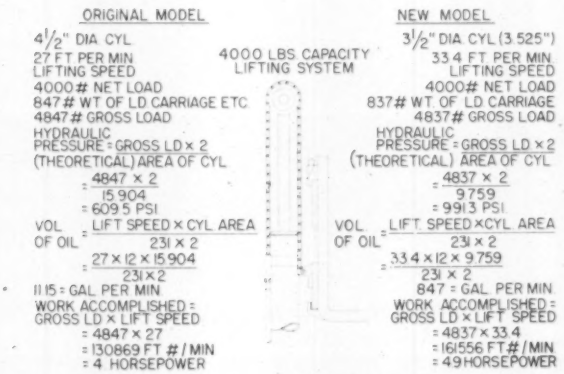

ORIGINAL MODEL
4½" DIA. CYL.
27 FT PER MIN. LIFTING SPEED
4000# NET LOAD
847# WT OF LD CARRIAGE ETC.
4847# GROSS LOAD
HYDRAULIC PRESSURE = GROSS LD × 2 / (THEORETICAL) AREA OF CYL.
= 4847 × 2 / 15.904
= 609.5 PSI
VOL. OF OIL = LIFT SPEED × CYL. AREA / 231 × 2
= 27 × 12 × 15.904 / 231 × 2
11.15 = GAL. PER MIN.
WORK ACCOMPLISHED = GROSS LD × LIFT SPEED
= 4847 × 27
= 130869 FT #/MIN
= 4 HORSEPOWER
4000 LBS. CAPACITY LIFTING SYSTEM
NEW MODEL
3½" DIA. CYL. (3.525")
33.4 FT. PER MIN. LIFTING SPEED
4000# NET LOAD
837# WT. OF LD CARRIAGE
4837# GROSS LOAD
HYDRAULIC PRESSURE = GROSS LD × 2 / (THEORETICAL) AREA OF CYL.
= 4837 × 2 / 9.759
= 991.3 PSI
VOL. OF OIL = LIFT SPEED × CYL. AREA / 231 × 2
= 33.4 × 12 × 9.759 / 231 × 2
8.47 = GAL. PER MIN.
WORK ACCOMPLISHED = GROSS LD × LIFT SPEED
= 4837 × 33.4
= 161556 FT #/MIN
= 49 HORSEPOWER

Fig. 3 Comparison of original and redesigned hoisting systems of 4000-lb electric fork truck

urements of hydraulic pressure were made on the complete truck—using a single laboratory-type gage. This gage was connected to the several locations through a manifold which permitted reading pressures at the desired locations in rapid succession. Since the technique for determining losses in hydraulic lines is well known, only the final results are shown in the diagram, Fig. 5.

The total quantity of fluid passing any cross section is equal to the product of the

Average velocity in in. per sec, V', and the area of the cross section in square inches

$$A = \frac{\pi D^2}{4} \text{ for a circular section}$$

$$Q = 0.7854\, D^2 V', \text{ cu in. per sec}$$

$$V' = \frac{Q}{0.7854 D^2}, \text{ in. per sec}$$

Expressing V in ft per sec

$$V = \frac{Q}{9.425 D^2}$$

The Reynolds number for each section of line was computed from

$$\mathrm{Re} = 7740 \frac{VD}{v}$$

where

v = kinematic viscosity of the oil, centistokes
Based on an optimum operating temperature of 120 F, the value of v for the Sunvis 916 oil used in the hydraulic system of this truck is 20.8 centistokes

V = velocity, fps

D = pipe diameter, in.

Computation of power loss was based on pressure drop

$$L = 0.113\, QP$$

where

L = power loss, watts

Q = cu in. of oil per sec

P = pressure drop, psi

Note

$$\text{Horsepower} = \frac{\text{cu in./sec} \times \text{pressure, psi}}{12 \times 550}$$

$$\text{Watts} = \frac{746\, QP}{12 \times 550}$$

$$L = 0.113\, QP$$

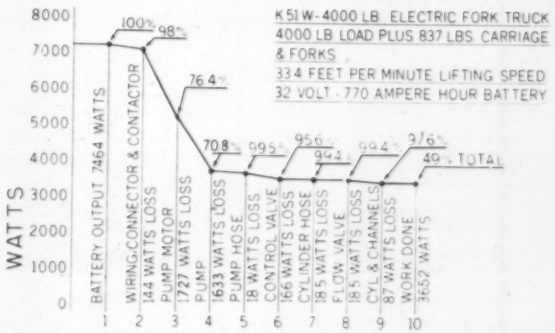


Fig. 4 Graph of measured power losses of electric fork truck hoisting 4000-lb load

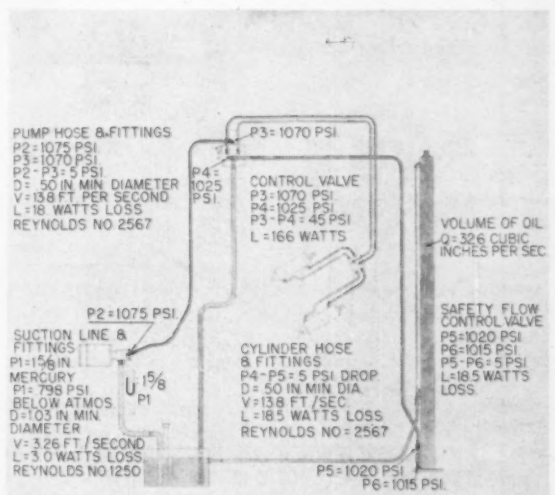

PUMP HOSE & FITTINGS
P2 = 1075 PSI
P3 = 1070 PSI
P2 - P3 = 5 PSI
D = .50 IN. MIN. DIAMETER
V = 13.8 FT. PER SECOND
L = 18. WATTS LOSS
REYNOLDS NO. 2567
P3 = 1070 PSI
P4 = 1025 PSI
CONTROL VALVE
P3 = 1070 PSI
P4 = 1025 PSI
P3 - P4 = 45 PSI
L = 166 WATTS
VOLUME OF OIL
Q = 32.6 CUBIC INCHES PER SEC.
P2 = 1075 PSI
SUCTION LINE & FITTINGS
P1 = 15/8 IN. MERCURY
P1 = 7.98 PSI BELOW ATMOS.
D = 1.03 IN. MIN. DIAMETER
V = 3.26 FT / SECOND
L = 3.0 WATTS LOSS
REYNOLDS NO. 1250
U 15/8 P1
CYLINDER HOSE & FITTINGS
P4 - P5 = 5 PSI DROP
D = .50 IN. MIN. DIA.
V = 13.8 FT / SEC.
L = 18.5 WATTS LOSS
REYNOLDS NO. = 2567
SAFETY FLOW CONTROL VALVE
P5 = 1020 PSI
P6 = 1015 PSI
P5 - P6 = 5 PSI
L = 18.5 WATTS LOSS
P5 = 1020 PSI
P6 = 1015 PSI

Fig. 5 Diagram illustrating hydraulic losses of electric fork-lift truck hoisting 4000-lb load

Although shown separately in the graph of power losses, Fig. 4, the losses in pump and motor cannot be considered as unrelated items. Based on prior experience, some choices of components warranting further study were made. The final arrangement should result in as near to maximum over-all efficiency of operation as possible. Such compromise as was necessary would be made on the basis of availability and cost. Lifting speed had been established—to obtain this speed necessitated a balance between cylinder size (which controls pressure), pump size (based on efficiency and delivery volume), motor characteristics, and battery discharge rate. Industrial batteries are rated on the basis of 6 hours to discharge the battery. If the 6-hour discharge rate of the battery is exceeded, power losses greater than normal will occur within the battery itself. High current draws also mean increased I^2R losses. In order to conserve power this type of system requires that the motor be started each time hydraulic power is required. The motor is connected directly across the line, and current inrush and acceleration factors become appreciable quantities. Careful design of the motor is essential for satisfactory product performance. The operating speed under any set of conditions will be established by the combined motor and pump characteristics.

Motor Selection

The cylinder size was established at $3^1/_2$ in. or 4 in. Using a $3^1/_2$-in-diam cylinder and a desired lifting speed of 32 fpm, from data previously given we tentatively established

Volume of oil required	8.5 gpm
Pressure at relief-valve setting	1500 psi
Pressure at rated load	1080 psi
Pressure at half rated load	625 psi

From past experience we selected a Vickers Model V-210 vane pump rated at 5 gpm at 1200 rpm. From the performance curve for this pump, Fig. 6, we determined that we required a motor capable of delivering 7.2 hp at approximately 2000 rpm. An available motor having these general characteristics as shown in Fig. 7 was selected. Dynamometer tests were run to obtain the pump and motor characteristics.

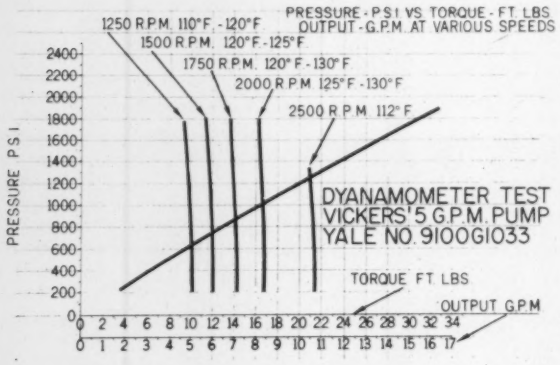

PRESSURE - P.S.I. VS. TORQUE - FT. LBS.
OUTPUT - G.P.M. AT VARIOUS SPEEDS
1250 R.P.M. 110°F. - 120°F
1500 R.P.M. 120°F. - 125°F
1750 R.P.M. 120°F. - 130°F
2000 R.P.M. 125°F. - 130°F
2500 R.P.M. 112°F.
DYANAMOMETER TEST
VICKERS 5 G.P.M. PUMP
YALE NO. 9100G1033
PRESSURE P.S.I.
TORQUE FT. LBS.
OUTPUT G.P.M.

Fig. 6 Dynamometer performance Vickers Model V-210 vane hydraulic pump

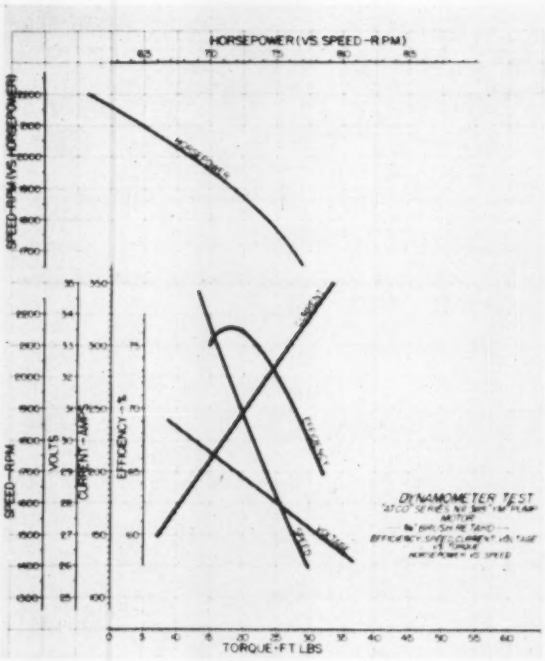


Fig. 7 Dynamometer performance Atco type YM pump motor

The performance curves of the pump, motor, and battery when plotted in their proper relation will reveal the operating characteristics of the particular combination. Such an arrangement of curves is shown in Fig. 8. The effect of excessive current draw on available power is immediately evident from this diagram. It is also apparent that sufficient battery capacity must be provided if the utilization factor of the battery is to be within usable range. It is possible, through use of similarly prepared diagrams, to evaluate the effect of any proposed change in the pump-motor-battery combination. The effect of load on elevating speed and the effect of voltage drop from either battery discharge or conductor resistance may be accurately predicted from these curves. Since the cylinder size is limited by the dimensional restrictions of the truck, the pump-motor-battery combination is the major point at which to reduce power losses.

Control Valve Redesigned

The choice of control valve is based on commercially available models having sufficient capacity as determined by the pump delivery and pressure.

Sudden operation of a control valve or the hydraulic shock at the transition point in a two-stage cylinder may cause instantaneous values twice the operating pressures. Testing of control valves which are commercially available in sizes suitable for application to fork trucks indicated a wide variation in performance. One particular area which caused considerable power loss was the relief valve. A careful study of performance revealed a loss of lifting speed—hence increased power required after a hydraulic shock. It was definitely es-

tablished that the relief valve was opening at the shock pressure—but was not reseating.

The normal use of an industrial truck involves frequent operation at relief-valve pressure. The ideal condition would be zero differential—remaining fully closed up to the point of relief-valve setting and then relieving the full volume without increase in pressure, also a zero pressure differential between opening and closing of relief valve. It is difficult to evaluate the power loss due to operation at relief-valve pressure because the time interval is under the control of the operator. Fig. 9 shows the results of a redesign of the relief valve in one commercially available valve.

Based on a relief-valve setting of 1500 psi and a delivery as shown in Fig. 8 of 6.9 gpm, we can estimate the effect of this relief-valve redesign. In tilting to load-transporting position the operator will hold the relief valve open approximately two seconds. The loss in power when the pressure rises to 1695 psi as shown on the original relief valve is

$$L = 0.113\,QP = \frac{0.113 \times 231 \times 6.9}{60} \times 1695$$

= 5085 watts per sec which, when divided by the motor efficiency of 63.5 per cent and the battery utilization factor of approximately 0.56 for the appropriate current draw, becomes 14,300 watts per sec

while the loss for the redesigned relief valve is

$$L = 0.113\,QP = 0.113 \times \frac{231 \times 6.9}{60} \times 1525$$

= 4580 watts per sec which, when divided by the motor efficiency of 67.8 per cent and the battery utilization factor of 0.60 for the appropriate current draw, becomes 11,280 watts per sec

If we assume an average cycle of 2 min, the relief valve operates for 2 sec per cycle, and 80 per cent utilization of the truck, for an 8-hr day we find

$$\frac{8 \times 60 \times 0.80}{2} = 196 \text{ load cycles per shift}$$

$$\frac{14{,}300 - 11{,}280 \times 2 \times 196}{3600 \times 1000} = 0.329 \text{ kwhr saved through improved relief valve}$$

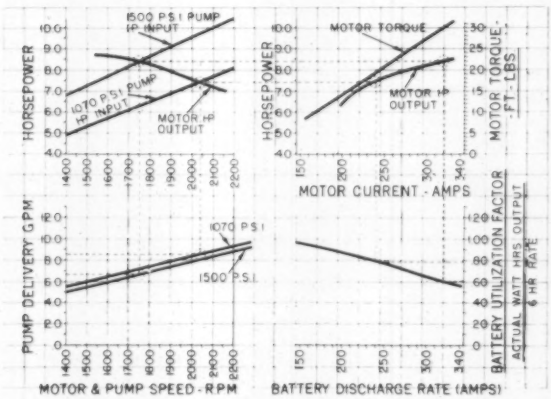


Fig. 8 Arrangement of performance curves of hydraulic pump, pump motor, and battery utilization

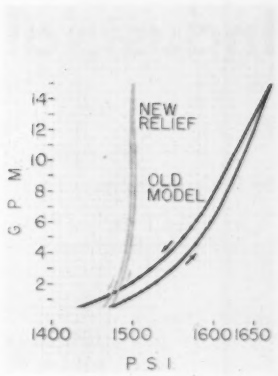


Fig. 9 Comparative performance curves of original and redesigned hydraulic-control valve relief valve

Based on an available battery capacity of 23.61 kwhr, this represents 1.39 per cent saving.

The power loss through the flow control valve is small. It is also regarded as the minimum obtainable with current designs. The purpose of the valve is to limit the rate of descent of the load in event of a line failure. It is an essential safety device.

The power loss in the cylinder has received considerable study. Various types of packing have been tested. The design of this type of equipment results in a very short bearing span for the piston rod when fully extended. The stiffness of the piston rod and the material used in bushing the gland have considerable bearing on the power loss in the system, especially at extreme lifts. All of these factors have been the subject of considerable study and refinement of design.

Heat Dissipation

The net effect of all the losses is heat. The problem of dissipation of this heat further involves the problem. In many applications the motors must be enclosed, hence every effort must be made to provide the most efficient electric motors available. In order to protect the oil reservoir, it is generally located well within the frame of the truck, making radiation a problem. Any measures which improve the efficiency of the hydraulic circuit will result in less heat in the oil, which in turn means longer life of all the parts.

Conclusion

In this brief discussion only the hoist circuit has been reviewed. The tilt circuit should be considered in the same manner, as should all hydraulic attachments. Undoubtedly many questions will arise in the reader's mind. This paper is intended to indicate one approach to this type of problem, and to discuss some of the facets of the problem, rather than to provide a complete and detailed analysis whereby any similar problem may be solved. Many of the decisions made in this type of design are predicated on the economics of the problem.

The main conclusion reached from the study is that the internal resistance losses in the battery, when the current draws are in excess of rating, far exceeds any normal losses in the hydraulic system; hence this is one of the most important considerations in the design of battery-powered equipment.

Industrial Engineering

... A Definition and Forecast[1]

By D. G. Malcolm, Mem. ASME

Director of Operations Research,
Booz, Allen & Hamilton, Chicago, Ill.

THE growth of the industrial-engineering profession during the period 1940 to 1950 was truly phenomenal, as is evidenced by United States Census Bureau figures. During this period the over-all engineering profession experienced a growth of 51 per cent in individuals reporting some branch of engineering as their occupation specialty. During this same period the number of individuals listing industrial engineering increased at $7^1/_2$ times this rate or a figure of 376 per cent—the total number of industrial engineers being 46,700.

There are undoubtedly several reasons why these figures should be suspect. The problem of categorizing, for census purposes, a lot of individuals who became specialists in management problems during the war years, probably forced many nonengineering individuals into this category. This fact also has had a lot to do with the breadth of the functions ascribed to the profession and the general vagueness in its definition. Many of these individuals undoubtedly would not be considered professional industrial engineers today. It is interesting to note, however, that if the census figures are discounted by as much as 50 per cent the growth was still in excess of that of chemical engineering, the next leading branch of engineering in growth during the period.

This growth has been rather uncoordinated, generally neglected, and undirected philosophically by academic engineering groups in our universities. The growth also lacked a professional society which could spell out the engineering objectives of the profession and the problem areas wherein development could and should be concentrated. As a result of such factors operating, or rather not operating, we find that the definition of industrial engineering varies considerably—depending mostly on the experience of the person with whom one is talking.

It has been characteristic of the engineering profession in America to develop along the lines of problems currently needing solution in our economy and society. Thus in retrospect, it seems quite natural that when problems of organization and management in industry require systematic study by what is referred to as the "engineering approach," the resulting knowledge and material should be grouped in this rather vague area referred to as "industrial engineering." The development during the war years was not characterized by the development of analytic tools but rather by the development of descriptive technique that literally caused the problems to disappear by shedding the light of systematic fact upon the problems then under study. The techniques developed were and are adequate for these purposes.

However, during this same period, other engineering disciplines had undergone a fundamental and pervasive shift from emphasis on the practical and experimental approaches, the *art of engineering*, to the use of mathematical methods of analysis, refined through the cooperative work of scientists, mathematicians, and engineers. As a result, the *science of engineering* as an era evolved. Thus the present-day engineering function is characterized by the development and use of a considerable "research" function which develops new analytical approaches and probes into the basic structures of our physical world. This same sort of approach is beginning to pervade the industrial-engineering profession, offering opportunities to develop in an accelerated manner along similar analytic and research lines.

An Engineering Definition

We can now make an *engineering* definition of the industrial-engineering profession. A major purpose in such a definition is to provide a means of permitting the orderly growth of a body of design knowledge for engineering functions normally considered within the sphere of industrial engineering. In this vein, I would like to offer such a definition, mindful of the fact that definitions have a dynamic quality, since the semantics of today probably will not be sufficient for tomorrow, and that the definition of engineering itself is a changing factor:

> Industrial engineering is that branch of engineering concerned with the *continuing analysis* of the dynamic relationships between men, materials, machines, methods, and information, and the *synthesis* of these elements into the design of organizations, the work situation, and various types of controlling systems for the purpose of enabling the achievement of some desired ethical objective (generally at the least cost of company money and worker effort expended, and providing the maximum satisfaction of all parties involved). The industrial engineer is charged with the responsibility for the installation and the successful performance of these human systems and for providing adequate predictions of their performance and cost.[2]

The same words that have been used in the definition are used in block form to show the "process of industrial engineering," as it may be termed. Box 1, Fig. 1, marked "analysis," indicates that the job of analysis is to con-

[1] Condensed from "The New Industrial Engineering," *The Journal of Industrial Engineering*, vol. VII, no. 6, November-December, 1956.

[2] Members of the Cornell Symposium on Industrial Engineering developed the following definition which has been officially endorsed by the American Institute of Industrial Engineers at its annual convention, May 19, 1956:

Industrial Engineering is concerned with the design, improvement, and installation of integrated systems of men, materials, and equipment—drawing upon specialized knowledge and skill in the mathematical, physical, and social sciences, together with the principles and methods of engineering analysis and design, to specify, predict, and evaluate the results to be obtained from such systems.

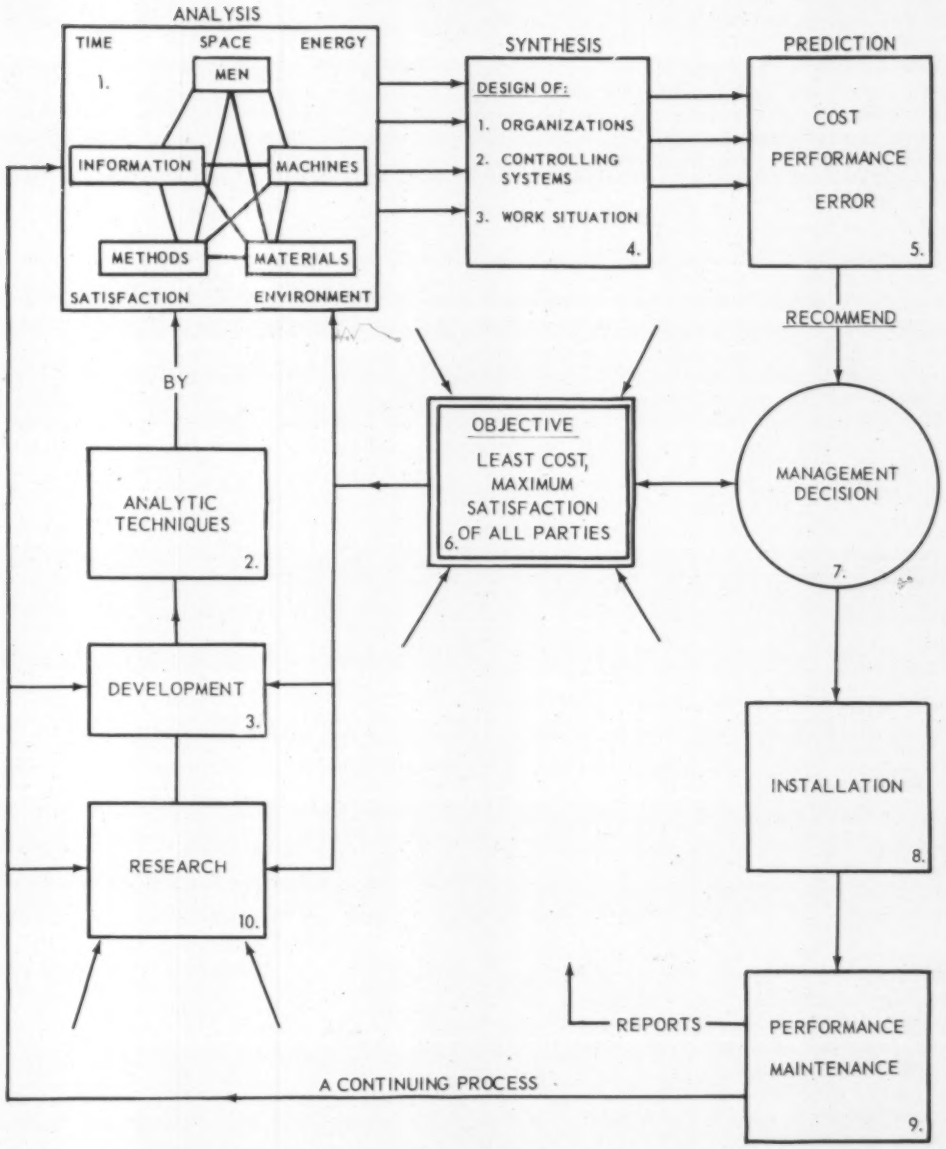


Fig. 1 The industrial-engineering process—a continuing analysis of the dynamic relationship between men, machines, materials, methods, and information for synthesis into the design of organizations controlling systems or the work situation which meet the dual objective of providing a least-cost solution and also the maximum satisfaction of all parties involved

sider the various combinations of relations between men, machines, materials, methods, and information either in respect to time or with regard to distance, environment, satisfaction or the energy involved, or in respect to all of these values. This is done by one of many, sometimes alternative analytical techniques in order to get the facts of the relationship and to provide a basis for the synthesis of the facts, or elements, into a design for an organization or controlling system or the work situation.

Then the industrial engineer should be able to predict the cost and the performance of these designs under varying conditions and to give some statement of the probable error of his prediction. Upon comparison of alternative suggestions, a recommendation is made to management for review and either acceptance or a suggestion of modification or a new analysis.

In any situation, at some time there will be forthcoming an approved design, at which time the industrial engineer's responsibility will be to make or assist in an installation of this design. The installation is generally quite a time-consuming job and, as evidenced by much

of the literature of industrial engineering, there is a continual job of what might be termed "fire fighting," in order to make sure that the installation sticks and is satisfactory. Box 9 indicates that the industrial engineer is responsible for the performance and maintenance of this system (not its operation, however) and may be responsible for periodic reports of all types that may be used by management.

The loop back has been drawn to indicate that all of this should be a continuing process. That is, these particular systems or methods should be looked into continuously from the point of view that experience gained in performance and experience gained from research into the newer techniques of analysis will provide for the development of *different* system syntheses. Some of the problem areas caused by trends in business such as automation, emphasis on development, and our rapidly expanding technology are best indicated by a look at this return loop and reflecting that the industrial engineer has often lost sight of the fact that he is dealing with a continuing or dynamic process. He has quite often arrived at a design of a system, installed it, and in effect has failed to consider this return loop. Too often he merely monitors the methods and produces the reports. In many cases, industrial engineering operates almost entirely within box 9 and often without real consideration of boxes 2, 3, 4, 6, and 10.

Analytic Techniques

A second problem area concerns the analytic techniques that are being used and, more importantly, the research activities that produce the *new* techniques about which we are hearing. It should be mentioned that the functions marked "research" and "development" refer to the research and development supporting industrial engineering methodology and not to the research and development on the product of the company.

Some of the various techniques of analysis of box 2 that have been used by industrial engineers are, very roughly, in the order of their development and application: process charts, motion study, flow diagrams, surveys, work measurement, fatigue studies, cost analysis, engineering economy studies, mathematical methods, statistical analysis, programming, stochastic processes, servo theory, communication-information theory, system simulation, and factor analysis.

Toward the end of the list will be noted a whole host of new techniques, or analytical methods, that are looming up over the horizon. How do these fit into the new industrial engineering?

First, it is important to recognize that such techniques are being developed by other than industrial engineers as well as by industrial engineers. Some of the techniques are merely in the research stage and are requiring considerable development in the way of specified procedures by the industrial engineer in order for successful applications to be made.

Second, the distinguishing characteristics of these new methods of analysis are (refer to box 1):

1 Some of the newer techniques permit inclusion of more variables in the analysis that may be important in the design. Most present techniques consider only two or three variables; e.g., men and machines with respect to time or space.

2 More of the variables may be considered simultaneously and in a dynamic method that permits a better insight into their interaction. Many of the techniques are essentially competitive and are often alternative tools for solving the same problem.

3 As a result of making analogs of the real system—either mathematical models or computer models—evaluation of different designs for control systems can be made. Thus we can look forward to a *theory* of inventory control, a *theory* of production control, and the like.

The impact of this development will be considerable but not as revolutionary as some would have us believe. While many of the present industrial-engineering techniques are essentially descriptive and the over-all effect of the industrial-engineering approach is sometimes experimental, the good judgment and experience of the business system have been sufficient and adequate to come up with decisions that are probably quite satisfactory and will probably continue to be. However, many of the questions in regard to, say, inventory control, concerning optimum reorder points and quantities and the optimum inventory size considering production efficiency and all distribution costs have been answered by experience rather than by analysis.

Competing techniques of system simulation and servo theory are offering the possibility of analyzing such systems in a dynamic context and permit analytic determination of many policies and procedures, thereby providing a basis for the development of optimum sets of rules.

The technique of system simulation (sometimes called the Monte Carlo method) and stochastic processes are permitting analysis of interference problems and balancing and peaking problems. Where we have formerly considered only the average time, it is becoming possible to allow (in the analysis) for the variable nature on many of the elements in a production line.

Synthesis and Design—The University's Role

The results of the analysis, whatever type it may be, lead to the process of synthesis, box 4. Thus industrial engineers design organizations, controlling systems, and the work situation. Typical examples in each design area are: (1) Organization—procedures, structure, policies, and measures of effectiveness; (2) Control Systems—quality control, production control, inventory control, and cost and budgetary control (labor, support staffs, and organization); and (3) Work Situation—materials handling, plant layout, work methods, wage determinations, and maintenance.

There has been a tendency in industrial-engineering academic research to overconcentrate on the detailed analysis of the work methods. While these are necessary lines of investigation, a lack of scientific attention to the over-all work pattern has resulted. Simply stated, there has not been nearly enough attention paid to the more powerful analytic tools for system analysis.

However, at this time, a survey of our universities indicates a real drive and effort to move in this latter direction. Many of our colleges now have the goal of training engineers to be in a position to introduce change in about 15 years—not merely to be able to keep up with it. Fifteen years is chosen because this represents approximately the time before the engineer is able to make the most effective contribution to his company. Courses in linear programming, probability theory, information theory, servomechanisms, operations re-

search, etc., are appearing at an increasing rate. As greater experience is gained by faculty members, there will be a shifting of emphasis in the appropriate undergraduate technical courses for the industrial engineer. The basic mathematics of the industrial engineer differs from that most useful in other engineering branches.

Thus industrial-engineering managers should begin to have a wider range of training from which to select new employees, and are already finding it necessary to modify their organizational structure in order most effectively to use these talents. It may well turn out that graduate engineers from other engineering branches, research groups, etc., will be more satisfactory employees for the industrial-engineering department before this educational process is fully established.

To summarize, it is evolving that the greatest payoff in the coming decade will probably come from increased attention in this systems area. A theory of organization seems to depend first upon satisfactory solution to the problems of control. We can look forward to communication-information theory to be very useful in getting at the problem of optimum communication flow. As one enthusiastic writer[3] indicates, "The particular strength of the communication theory lies in its ability to describe in the precise language of mathematics the statistical performance of all components, human or mechanical, of the industrial engineer's realm."

Prediction of Cost Performance and Probable Error

The methods for prediction of cost performance and probable errors in these estimates are requiring more attention. In order that the right decisions will be made and installations of new systems may be effected in the least time, more frequent, elaborate, and accurate predictions will be required. These will require consideration of the likely trends in labor relations, the increasing number of technological choices available, the likely need for increased frequency of change in basic processes and methods, and an increased knowledge of what a competitor is doing in *his* process. The techniques of time-series analysis, time-reduction curves, and mathematical programming will receive increasing attention.

Management Decision and the Objectives of the Enterprise

Management is entering the picture in more than one way, as evidenced by boxes 6 and 7. Management is continually looking at this heart of the system—box 6. What are the over-all objectives and policies that will permit the most satisfactory growth or profit of the entire enterprise? Management has the job of fitting together many other functions, of which industrial engineering is only one, into a best over-all solution.

While this "heart" is being worked on from many factors from the outside, we can say that modern management is quite aware of the need for expression of human values to be included in systems design and at the same time is mindful of the need to produce the best possible product at the least cost of money and worker effort. As a result of this philosophy, management is asking questions concerning the adequacy of the methods of analysis employed. This is causing a greater emphasis on research and development of techniques for better, more timely, and comprehensive analysis.

The new industrial-engineering function that is emerging is being characterized by this gearing of management thinking to box 10. More and more industrial-engineering functions are building-in a research function. This will permit understanding and application of the newer methods of analysis at an earlier date and should have the return of permitting a broadening of the objectives of the entire enterprise. This in turn is an important competitive tool in today's manpower shortage.

Installation Theory

The industrial engineer is generally responsible for the installation of his designs. The length of this installation phase and the frequency of introducing change are subjects of increasing importance.

It is generally desirable to install a system, etc., with the minimum of confusion, so that the learning effect (time-reduction curves in the aircraft industry) is minimized. Also, with the general desire on management's part to be able to introduce new models, or products, at an increasing frequency, it becomes necessary to select the analytic technique (where different tools are available) that minimizes the total cost of the production.

So it should be evident that there are gains, by way of reduced cost and competitive advantage, to the enterprise that is able most successfully to cope with this "installation phase." It therefore becomes quite important for more systematic knowledge to be brought to bear on how long it takes for a control system, an organization, etc., to respond to the new desired way of doing things. To reduce the installation time requires a feedback to research and development and should be the subject of considerable exploration by the industrial engineer.

With everyone else coming up with a "theory of this," or a "theory of that," perhaps this offers the industrial engineer a chance to coin a theory also—perhaps this area of study of the installation schedule and procedure should be referred to as "installation theory," with its objective the "study of the most over-all efficient way of introducing a change."

Performance and Maintenance

In many companies the responsibility for the performance of others in regard to a given design is the ultimate responsibility of the industrial engineer. If they or the system can't do what he says is possible, it becomes the industrial engineer's job to determine the source of the trouble. If his design is at fault, he has a redesign job to do; if line management, supervision, or interpretation is the source of the trouble, the industrial engineer must insist on correct procedure.

There is a trend in the industrial-engineering function to get out of the data-processing area. Thus reports issued by industrial-engineering departments are now more of the nature of interpretive reports of other organizational functions whose systems the industrial-engineering function is responsible for designing.

The industrial-engineering department conceived as an internal consulting function may well become an organizational precept and indeed is the central theme of the new industrial engineering.

[3] "The Industrial Engineering Application of Communication-Information Theory," by A. B. Rosenstein, *The Journal of Industrial Engineering*, vol. VI, no. 5, September-October, 1955.

"Zytel" Nylon Resin

... A Versatile Engineering Material

By W. C. Warriner and A. J. Cheney

Polychemicals Department,
E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.

ZYTEL nylon resin belongs to the familiar nylon family of materials which has become an accepted and indispensable part of our modern life. People generally recognize nylon as the glamorous fiber seen so often in textile applications, but some are unaware that the nylon molding material known as Zytel is equally useful in almost endless numbers of applications.

ZYTEL nylon resin is supplied in granular form approximately $^1/_8$ in. × $^1/_8$ in. × $^1/_4$ in. suitable for injection and compression molding and extrusion in standard machines. This molding material has enjoyed many successful applications over the past ten years. For certain applications, this material offers the designer freedom from many of the conventional methods necessary for the fabrication and machining of metals. Sleeve bearings, gears, electrical coil forms, and even horseshoes, each utilizing some of the many unique properties of this versatile material, are being molded to meet an ever-increasing demand. Intricate parts can be produced at low cost in large volume and require, in most cases, no machining operations to obtain the finished part.

Cost Trend

Zytel has been reduced in price 16 per cent in the past 18 months while most metal prices have increased sharply. Zytel 101 is currently selling at one half the price of brass.

Finishing costs for zinc, magnesium, and aluminum die-castings in most cases cancel out the relatively lower costs of the base material when evaluated against comparable Zytel 101 parts. The excellent molding characteristics of Zytel, including the ability to accommodate "molded-in" metal inserts, virtually eliminate the need for any finishing machine work.

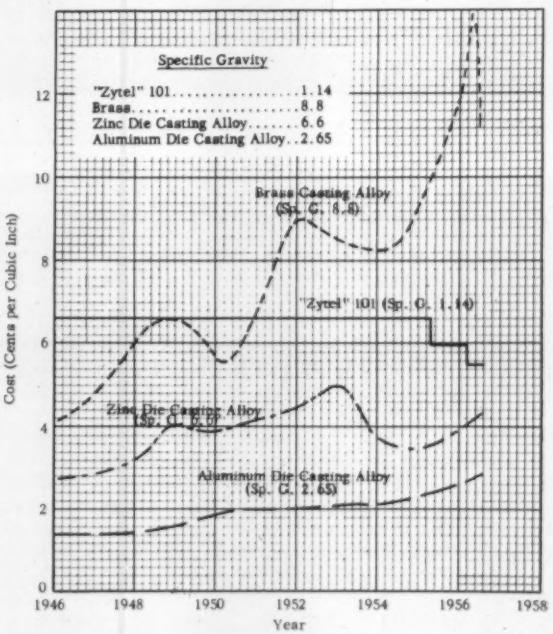
With this price trend in metals, cost-conscious engineers should review the design of existing products for applications of Zytel. The versatility of this material is an invitation to all designers to modernize their products and assure leadership in their respective fields.

Properties

Low Specific Gravity. For an engineering material, Zytel is extremely light and has a lower specific gravity than any of the die-casting alloys. Comparison of the specific gravity of these alloys shows: Zytel nylon resin, 1.14; magnesium die-casting alloy, 1.81; aluminum die-casting alloy, 2.65; zinc die-casting alloy, 6.6; and brass, 8.8.

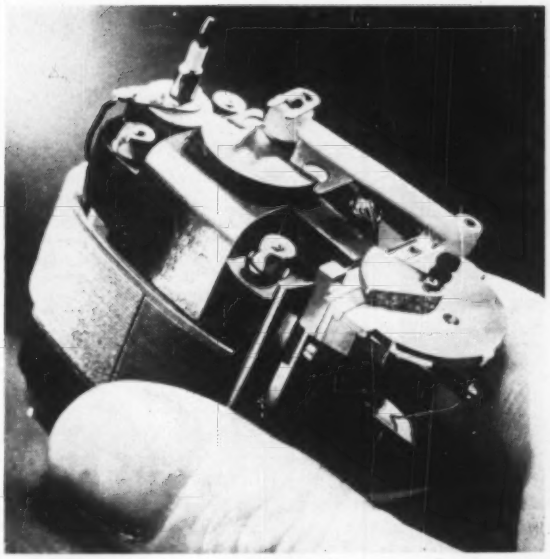
Thus where dead weight or inertia are design factors this material offers a possible solution. As an example, Zytel is being used successfully as a connecting rod in a popular electric shaver. This part transmits power from the motor to the cutter blade and reciprocates at speeds of 15,000 to 17,000 half-cycles per min. Molded Zytel provides lightness of weight, which keeps vibration to a minimum, and resiliency, which absorbs vibration and shock. Strength and toughness are provided, and the molded material is an excellent bearing surface which requires only initial lubrication during assembly.

Wear and Abrasion. Zytel is a resilient material and has high wear and abrasion resistance. This property is difficult to define in absolute values, so some comparisons will be given as illustrations. Ball mill



A ten-year comparison in the selling price of Zytel 101 molding powder and the ingot price of some of the competitive metals

Contributed by the Rubber and Plastics Division and presented at the Semi-Annual Meeting, Cleveland, Ohio, June 17–21, 1956, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Condensed from ASME Paper No. 56—SA-70.



Connecting rod of Zytel is a key part of this shaver. It absorbs vibration and gives long, trouble-free service.

tumbling tests resulted in a weight loss less than one tenth that of hard rubber, cast aluminum, or mild steel. Zytel is used extensively in lapping operations, since it will hold the lapping compound and wears slowly.

Zytel can be readily machined with metalworking tools similar to those used for yellow brass. Zytel is being used as elevator "gibs" (vertical guide bearing) because it resists wear and abrasion and requires no lubrication. These properties make it an exceptionally adaptable material for separators in ball bearings.

Impact. Zytel has excellent impact resistance. Since Zytel will deform more readily than most common structural metals, the designer can utilize this property to accommodate impact. The energy of impact is absorbed by a force developed in the part multiplied by the distance or deformation in the part. Designing the part subjected to impact, so that it can deform, is more easily accomplished by utilizing this intrinsic property of Zytel 101.

Rounded, instead of square rigid corners will produce a design more resistant to impact. Sound design, whether in plastic or metal materials, dictates the use of fillets at intersecting surfaces and where changes occur in the thickness of the cross section of a part. The lack of proper "filleting" will cause stress concentration and increase the possibility of failure due to stress cracking.

Relative impact tests obtained for several commercial plastics for a specific shape are shown in Table 1. As shown, Zytel is much tougher than any of the other materials under repeated impact.

Impact resistance for both notched and unnotched Izod samples increases with moisture content. Zytel 101 parts which have absorbed 2.5 per cent moisture (equilibrium at 73 F and 50 per cent relative humidity) will be approximately twice as tough as freshly molded parts. Thus moisture conditioning is important for parts exposed to impact loading.

Table 1 Relative Impact Tests (73 F)

	Izod (notched), ft lb/in.	Roller test,[a] in.	Repeated impact,[b] in.
Zytel 101[c]	2	35	30
Styrene-butadiene copolymer	2.3	3	2
Ethyl cellulose	2.8	9	5
Cellulose acetate butyrate	7	40	7
Styrene, butadiene, and acrylonitrile terpolymer	7	8	3

[a] Roller 0.7-in. OD × 0.35-in. ID hit on outer surface by free-falling 2.7-lb weight. Height of fall required to cause a visible crack in one blow.

[b] Same roller test but height of fall necessary to cause failure in ten blows.

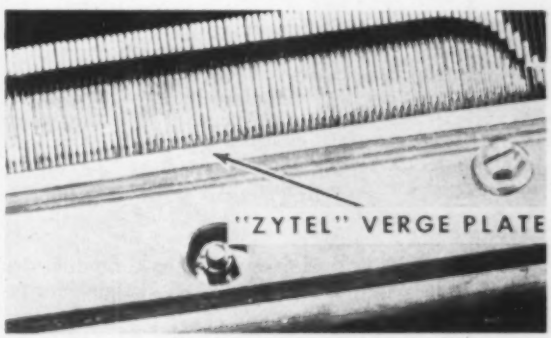
[c] Conditioned to 50 per cent relative humidity (2.5 per cent moisture content).

Weatherability. Zytel 101, like most plastic materials, is sensitive to ultraviolet light and is not recommended for continued outdoor exposure to sunlight. Zytel 105 BK-10, a black composition, has been developed for this service. It has approximately the same physical properties as Zytel 101 with the exception of impact resistance, which is somewhat lower. Weatherability of Zytel 105 BK-10 is excellent.

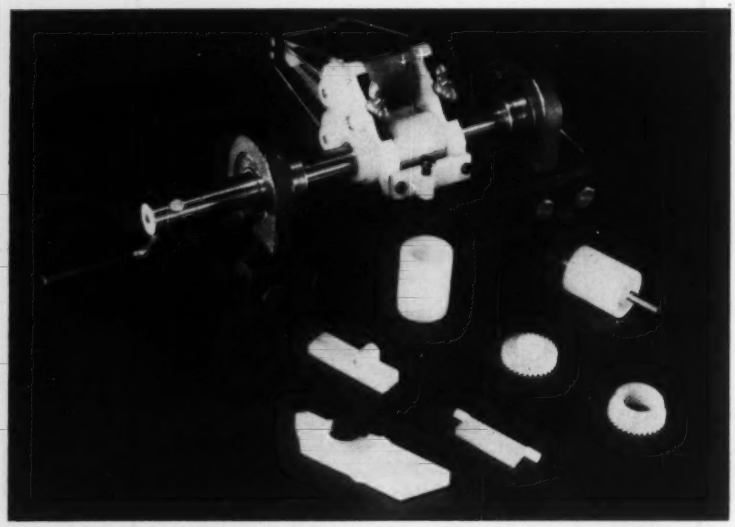
Chemical Attack. Zytel 101 shows high corrosion resistance to alkalies and organic solvents. It is unaffected by lubricating oils and greases and conversely does not affect the chemical stability of lubricants. The common solvents for Zytel are formic acid and phenol. An aqueous phenol solution is used for cementing or bonding separate parts of Zytel.

The effects of immersing samples of Zytel 101 in various chemical solutions for a 30-day period is shown in Table 2. With the exception of sulphuric acid, which attacked the Zytel, all the other materials were absorbed, but showed no evidence of chemical corrosion.

Oxidation. For continuous duty, Zytel 101 is recommended for temperatures below 150 F. Above this temperature, a heat-resistant grade, Zytel 103, should be used to obtain a satisfactory service life. Zytel 101 has better impact resistance than Zytel 103; however, for some installations this reduced impact resistance is not critical. A comparison of service life between Zytel 101 and Zytel 103 at various temperatures is shown in Table 3.



Impact resistance and resiliency are the key properties of molded Zytel nylon resin in this verge plate, a part used in the knitting of full-fashioned hosiery. This close-up of the sinker-head assembly shows action of sinker-backs, striking against verge-plate insert of Zytel.



All moving parts and bearing surfaces in this long draft unit (used in textile spinning operations) are made of Zytel nylon resin. The Zytel parts need no lubrication, give longer life, and improve the quality of yarn produced.

Table 2 Effects of Chemicals and Solvents on Zytel 101 at 73 F

Immersion for one month in:	Weight gain, per cent	Tensile strength, psi	Remarks
Sulphuric acid			
3%	4.9	4600	Change due to chemical action
30%	7.0	4300	"
Sodium hydroxide			
1%	4.9	9000	Change due to moisture pickup only
10%	3.1	8100	"
Ethanol			
50%	7.1	7600	"
95%	3.4	8000	"
Sodium chloride			
10%	3.7	10000	"
Ethyl acetate	0.1	10100	Change due to material absorbed
Carbon tetrachloride	0.6	9750	"
Toluene	0.6	10000	"
Heptane	0.6	10100	"
Acetone	0.1	10400	"

Table 3 Estimate of Service Life Under Comparable End-Use Conditions

Temperature, deg F	Service hours	
	Zytel 101	Zytel 103
170	1000	over 100000
200	250	over 100000
250	—	60000
300	—	1500

Table 4 Hydrolysis of Zytel 101 Estimated Service Life

(Exposure hours based on the point where elongation and impact resistance start to decrease)

Temperature of water, deg F	Exposure hours
212	1500
200	2400
180	5000
160	11000
140	24000

Hydrolysis. Zytel 101 is virtually unattacked by fresh water or sea water at temperatures below 150 F. Continued exposure of Zytel to water above this temperature will cause the material to hydrolyze. This results in a lower molecular weight and reduced structural strength. Zytel 101 can be exposed intermittently to water temperatures above 150 F. At 212 F, boiling water will slowly reduce the tensile strength until at 2000 hr this value has been reduced to 6500 psi (tested at 72 F). The elongation also drops rapidly after 1500 hr exposure to boiling water. An estimated service life in water at various temperatures is shown in Table 4.

Conclusions

Anyone in the field of design will have no difficulty designing in Zytel, and the necessary design data required are available.

Applications of this versatile material are varied and numerous. The textile and food industries utilize Zytel as a bearing and gear material where oil contamination cannot be tolerated. Business machines and home appliances have been designed to run quietly with virtually no lubrication by using Zytel 101 mechanical components, such as gears, bearings, cams, connecting rods, and rocker arms.

Excellent electrical properties and impact resistance offer the designer wide opportunities for reducing costs in the manufacture and assembly of household appliances. Permanent molded-in decorative colors create added sales appeal at no additional cost.

Chemical resistance to fresh and salt water offers possibilities to the segment of industry engaged in designing consumer items exposed to the sea.

The hardware industry has found in Zytel a material which has many properties ideally suited for their use. This field has traditionally used brass in many consumer products. With brass ingots costing twice as much (volume basis) as Zytel 101 nylon resin, the designer of hardware and other brass products has a double incentive to use this economical material.

As the foregoing illustrations indicate, our lives are touched daily by Zytel in one form or another, and this versatile material has already taken its place in the ever-broadening spectrum of engineering materials.

The Essential Factors of Good Management

A restatement of a problem that offers every thoughtful reader new faith in the American way and in his own responsibility for the future

By H. W. Prentis, Jr.[1]

Chairman of the Board, Armstrong Cork Company, Lancaster, Pa.

SINCE the basis for the Gantt Award pertains to "industrial management as a service to the community" it may not be inappropriate to put stress upon the qualifications—the essential factors—involved in good management rather than on the specific techniques involved. The prime ingredients of good management fall under three main heads: First, some knowledge of the rudiments of psychology which deals with the human relations of business; second, some acquaintance with the basic principles of economics which has to do with its fiscal operations; and, third, a thorough understanding of the principles on which the American Republic rests which determine the climate under which business has to be conducted.

Knowledge of Psychology

Obviously, to be a good manager, an executive must know the motives that activate men in our modern industrial society. Dr. Thorndike, the famous psychologist at Columbia University, defined these forces some years ago, as follows: "Next to hunger, sex, physical safety, and intolerance of bodily pain come five other forces in our present American and social life, viz., (*a*) the satisfyingness of activity, mental or physical, at which one can succeed; (*b*) the satisfyingness of mastery; (*c*) the satisfyingness of submission to the right kind of leadership; (*d*) the satisfyingness of company and cheerfulness; and (*e*) the satisfyingness of that feeling that one is somebody of consequence—the sense of approval."

By the "satisfyingness of mastery," Dr. Thorndike means that everyone, whether he works with his head or his hands, likes to feel that he is a real craftsman and not merely a saw and hammer carpenter. In other words, that one has really mastered his vocation and is the captain of his own fate.

Men like to be led. That is why Dr. Thorndike mentions "satisfyingness of submission to the right kind of leadership." I do not mean to imply that men want to be ordered around by a martinet, but in whatever post a man labors, he never ceases to crave sources from which to seek help and assistance. Everybody likes leadership of the right kind.

There are, of course, different ways of applying leadership. Fifty years ago there was a great deal more driving and less leading than there is today. This shift in emphasis has been one of the great advancements in management: The development of the techniques of leadership—learning how to inspire a man to give his best instead of ordering him to do a specific task.

For good management and good results "the satisfyingness of company and cheerfulness" cannot be overemphasized. After all, the man who is unhappy in his work or dissatisfied with his environment or his associates cannot function with maximum efficiency. So the good manager will make every effort to create the necessary physical conditions under which a man can give his best.

Provide Work Satisfaction

But of all the five forces which, according to Dr. Thorndike, motivate modern men, the fifth factor that he mentions, namely, "the satisfyingness of that feeling that one is somebody of significance—the sense of approval." is the most important in our modern industrial age. The good manager who understands this fact will make his men feel that they are a part of a living, functioning organization in which they are truly important. The realization of this objective will add immeasurably to the zest and efficiency with which men tackle the tasks to which they are assigned.

The manager who understands human psychology will realize that the pay check alone never satisfied anyone. All men are tarred with the same stick and they want a chance to give expression to their creative instinct. After all, money, as important as it is, in the last analysis finally leads only to multiplication of possessions. I can only wear one pair of shoes at a time, I can only sleep in one bed at a time, and I can only wear one suit of clothes at a time. So, if a man relies solely on physical things to give him happiness as he gets older, he finds life a pretty empty proposition. Hence to be content our employees must feel, must find the satisfaction, the thrill of being active participants in the enterprise as a whole of which they are a necessary part.

For example, there is the old story about a man who visited a cathedral while it was under construction and talked with three of the stonemasons. He asked one stonemason, "What are you doing?" "I'm working for $10 a day." Said the second one, "I'm cutting stone." Then the visitor asked the third one, "What are you doing?" and he said, "I'm helping to build this cathedral." Now the first mason was an automaton, the second was an opportunist, and the third was an idealist. The first fellow was serving time, the second was serving himself, and the third was serving society. If we can just get the feeling of that third man into the hearts of our employees, we will be well along the road toward achieving the goal we seek.

[1] Past President, National Association of Manufacturers. Condensed from a talk at the Gantt Award Luncheon, Hotel Statler, New York, N. Y., Sept. 17, 1956, of the American Management Association and THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

However, mere management understanding of human nature will not of itself make employees feel essential and needed. The principles of basic psychology must be applied through constant and vigorous communication. We must utilize every means at our command—every medium of the written and spoken word—if we are to help our people identify themselves with the interests of the business.

Good Employee Communications

Much has been written and said in recent years about so-called employee communications, and a good bit of the comment tends to make communications a complex and involved science. While I admit that it is complex, I do not believe that communications are at all mystical or in the realm of hocus-pocus. I thoroughly agree with Harold Smiddy of General Electric who recently said: "A great deal could be accomplished if we would consider communication in the light of this simple, four-word formula: Talk to the guy."

That may be oversimplification, but the formula has much to recommend it. We should talk to the guy and when we do, we should tell him why. In no other way will he be able to get an understanding of what the business is all about and how his own personal fortunes are related to it.

When we talk and write to our employees, we should strive to bring about that broad and sympathetic understanding which is so essential to the continued progress of our American free-enterprise economy. To do this we must approach things from the employees' point of view, we must deal in specifics that are meaningful and understandable to them, and we must be forthright and scrupulously honest.

In our communications there are several basic themes that we should elaborate and expand while playing them over and over again until they become as well known to employees as a familiar symphony is to a music lover. It is quite easy to state these themes. Productivity is the key to plenty. Only by increasing total output is it possible to increase the workingman's share. Capital is essential to provide the tools and equipment which multiply human effort and make possible greater output per man hour worked. Profit represents the "wages," if you will, for the work that is done by capital without which savings would not be invested. Business, of necessity, operates in the public interest because of the customer's right of choice in a free market. Business *is* interested in the personal welfare and security of its employees and their dependents. And finally, lasting job security for everyone connected with an enterprise is dependent upon satisfied customers.

I have, of course, stated these themes in foreshortened and simplified terms. They are, however, statements of fact, as all of you fully realize. The task of a good manager, then, is to gain understanding and acceptance of these fundamental truths by his working people through his actions as well as by words, in day-to-day operation.

Knowledge of Economics

Another essential factor in good management is a knowledge of the rudiments of economics. Under our system of private competitive business, no enterprise can survive unless it makes a profit. So the importance of earning a profit will be constantly in the forefront of every good manager's thinking and he should not be ashamed to say so. When we talk about profits, we should never forget that we really have—not a profit system—but a profit *and* loss system. The opportunity for profit is always balanced by the chances for loss. And all profit sooner or later is spent on wages or used up in losing investments and thus returned to consumers in consumption goods.

Only through constant investment of new capital can we furnish the tools necessary to provide jobs. How can such needed capital be secured? There are only two possible ways: Either from the income gained from private competitive business, or from taxation of that income by government. The socialists believe it should come by the government route and, if their method is followed, the government must then necessarily become responsible for the over-all planning of the nation's economic life. Note here that I am not talking about voluntary planning. We need all of that that we can possibly get from government, business, labor, and agriculture. But over-all economic planning by government is not voluntary. It is a horse of quite another color. It ultimately means, as Peter Drucker says, "The abolition of all limitations on governmental power." This fact gives added emphasis to the vital importance of profits.

The most sinister threat that hangs over the future profits of American industry at the moment is the continuing wage-price spiral of inflation. Every advance in wages that outstrips contemporaneous increases in productivity necessitating price advances, adds fuel to the fire of inflation. With the tremendous power that has been placed in the hands of labor leaders, most collective bargaining today has become bargaining in name only. However, unless managers of American business take a firm stand in the future against wage increases that are unjustified by increases in productivity, the wage-price spiral will eventually mount to such dizzy heights that a financial crash will be inevitable, and when that disaster ensues, the demand for government intervention will become so overwhelming that the national economic planners with their socialist leanings will be swept into power and the American Republic, as we have known it in the past, will cease to exist.

The historical cycle has always run: From bondage to spiritual faith; from spiritual faith to courage; from

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H. W. Prentis, Jr., is the twenty-fifth person to receive the Henry Laurence Gantt Gold Medal, established Nov. 19, 1929, for "distinguished achievement in industrial management as a service to the community."

Administered by a board comprised of representatives of The American Society of Mechanical Engineers and the American Management Association, the medal was first awarded posthumously to Mr. Gantt himself, a management engineer, industrial leader, and humanitarian.

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courage to freedom; from freedom to abundance; from abundance to selfishness; from selfishness to complacency; from complacency to apathy; from apathy to fear; from fear to dependency; and from dependency back to bondage once more. We have now apparently reached the complacency stage here in America—well toward the end of the cycle. The average man, when asked to think about the future, simply shakes his head and says, "I have never had it so good." The labor leader who, to maintain himself in power must constantly seek more and more for his constituents, presses his demands for higher wages and increased fringe benefits with little or no regard to their ultimate effect on the national economy. The business manager, caught in the vise of circumstance, feels himself virtually powerless, and the pots of inflation boil steadily higher and higher. Pericles said, however, that "the secret of liberty is courage." After all, there *is* something worse than strikes and consequent loss of production and profits; there is something worse than the acceptance of a sound economic wage rather than a higher wage exacted by the use of force; and that is the destruction of our form of free government. I dislike to cast myself in the role of a Cassandra, but I venture the prediction that, if the present complacency and apathy of the American public toward unwarranted wage and price increases are not soon altered, the next twenty-five years will witness the loss of our present form of free government and our lapse into some form of state socialism.

To prevent that dire eventuality calls for vigorous and courageous leadership on the part of industrial management—particularly the management of our larger manufacturing enterprises. For what they do necessarily sets the pattern for our smaller producers. Little help can be looked for from the average politician. He never likes to take a stand against what he considers to be the current popular view, even though he may know in his heart that the popular view is based on principles that are unsound and which will have disastrous consequences in the long run. We may well keep in mind this statement of Rousseau's: "We may acquire liberty, but it is never recovered if it is once lost."

Understanding the American System

This trend emphasizes the importance of the other essential factor of good management, namely, a thorough understanding of the principles on which the American Republic rests. Obviously, unless a governmental climate favorable to the continuance of private competitive business is maintained, free private enterprise will eventually wither and die. Hence, it is vitally important that the business manager should be fully equipped to defend the principles of American self-government at every opportunity that affords. So let us examine the basic tenets on which our liberty depends.

Our forefathers came to the shores of the American Continent impregnated with the principles of personal moral responsibility, the right of private judgment, and the right of free assembly which, together, filled them with a fervent passion and unshakable belief in the sacredness of the individual soul in the eyes of a Sovereign God.

With this religious principle as the foundation, they erected the tripod on which our individual freedom in America rests today. First, they maintained that if man did possess a sacred personality, he had the right to choose who should rule over him. On this thesis they reared the first supporting tower of our edifice of liberty—constitutional representative democracy. Again they argued that since man possessed a sacred personality, he had the right to think, speak, assemble, and worship as he saw fit. On that concept they erected the second tower of the structure of American liberty—civil and religious freedom. And finally they reasoned that any man endowed with a sacred personality had the right to possess for himself such portion of the God-given resources of the earth as he could win by honest toil and effort. Thus they asserted every individual's right to private property and economic activity of his own choice, and on that basic tenet they built the third supporting tower of their temple of liberty—private competitive business. These three towers stand or fall together. Destroy any one of them, and the tripod on which our freedom rests soon collapses.

From this same religious concept they derived the two basic theses that they employed in setting up our peculiar system of popular self-government: First, they concluded that, since God had created man in His own image with the power to distinguish between right and wrong, every individual ought to listen with respect to the opinions of his fellow citizens and that whatever judgment was expressed by the majority of such divinely created human beings after full and free discussion, was likely to be closest to God's will for all of them. Vox populi, vox Dei—the voice of the people is the voice of God!

Their second thesis was equally logical, namely, that every mortal soul is endowed by its Creator with certain natural inalienable rights that no human agency whatever may justly invade—neither any man called "king," nor any group of men representing a temporary majority called "government."

Constitutional Representative Democracy

The problem, therefore, was how to combine these two opposing principles—the will of the majority and the rights of the individual—into a workable, durable government adapted to human nature in its manifold economic, intellectual, and spiritual aspects, and to a large population scattered over a big country. The founding fathers discarded the idea of a pure democracy in which all decisions would be made by the current majority, because they knew historically that pure democracies had never lasted long. They are too susceptible to demagoguery. As Samuel Adams said: "There never was a democracy that did not commit suicide." So they decided on a republic instead; that is, a constitutional representative democracy, so as to make effective the majority will of the people in governing themselves and at the same time not destroy the individual rights that the Creator had conferred upon each person.

To resolve the paradox that confronted them, our forefathers devised a governmental mechanism so ingenious, so carefully organized, so accurately compensated against human vagaries and lust for power that it led the great Prime Minister Gladstone to say that the Federal Constitution was "the greatest instrument of government ever struck off at a given time by the hand and brain of man." It includes at least seven specific political tools that we should always keep sharp, shining, and inviolate: In the first place, the Constitution provides for the complete separation of the legislative, executive, and judicial powers of the Federal Govern-

ment. In this connection, it is interesting to note that among the steps recommended by Harold J. Laski, the father of British Socialism, to bring about socialism in America was a shift toward a parliamentary form of government like that of Great Britain, because, in Laski's words: "The separation of powers is a protective rampart of American individualism." The Constitution also includes written provisions to safeguard individual and minority rights; sets up the principle of representative rather than direct action; divides responsibility among the Federal Union, and the states, counties and towns; provides for the control of the public purse by the House of Representatives, the arm of government closest to the people; seeks to prevent class cleavage by prohibiting the granting of any title of nobility; and limits the powers of the federal government in order to preserve local and individual initiative.

If we are serious in our desire to retain our freedom, as citizens we managers will test every new proposal of government against these seven political tools to see whether they fit soundly into the mechanism of our system. The best machine can be ruined by poor operators or by the use of the wrong tool. More than one free government in the world's history has been destroyed by the apathy of its citizens and their failure to utilize the political instruments at their disposal.

Individual Responsibility

But to understand the principles on which the American system rests is not enough. Self-government means self government. A free government will not run itself. To be successful, it requires the time and attention of every one of its citizens. No club, no lodge, no business can prosper unless some individual is willing to devote himself to its interests. The same thing is equally true of popular self-government. Unless we managers, we individual citizens are willing to give of our personal time and effort to help carry it on, it soon degenerates in quality and efficiency and will eventually fall into the hands of some power-seeking individual who will destroy our freedom completely just as Hitler did in Germany, Mussolini in Italy, and Lenin in Russia. Eternal vigilance on the part of the individual citizen is literally the price of liberty.

Too many managers, although acknowledging the truth of that statement, will say, "Well, what can I do about it? After all, I am personally quite unimportant." And there, in that attitude, lies one of the real weaknesses of a republic like ours, which the great Englishman, Lord Bryce, pointed out years ago: "The fatalism of the multitude—a sense of the insignificance of personal effort." If our free republic is to be preserved, we must not allow ourselves to fall into that pitfall. We must, instead, keep constantly before us the statement of Herbert Spencer: "What I need to remember is how infinitesimal is the importance of anything I can do, but how infinitely important it is that I should do it." As business managers, we will be derelict in our responsibilities to the nation and to our own businesses if we do not assume our individual duty in always standing for sound American principles, fearlessly enunciating them in our daily lives, and constantly seeking to implant them in the minds and hearts of the rising generation.

One of the best ways to accomplish this last objective is by encouraging a great revival of liberal arts courses in our colleges and universities, for it is on the teachings embodied in so-called liberal arts education that our freedom in America rests: The Greek idea of what constitutes a good life; the Roman concept of civic virtue based on a government of laws, not of men; the teachings of the great British and French political philosophers of the 17th and 18th centuries; the Christian principle of the dignity of the individual soul in the eyes of a Sovereign God.

Ever since the Civil War we have been so engrossed in material things that we have more or less compelled our institutions of higher learning to concentrate on scientific and economic subjects, forgetting that dealing with the concrete does not lead to knowledge of the abstract. Thus we have unwittingly cut ourselves off from the philosophic sources from which our liberty in America stems. Essential as specialization is in the operation of modern industry, it is unfortunately self-defeating in the field of citizenship in a Republic, because to be an intelligent citizen of a free society requires a broad knowledge of history, economics, sociology, politics, and religion, and a deep sense of social responsibility. Concomitantly the same qualifications coupled with constructive imagination, resourcefulness, and vision are essential in the higher echelons of business management.

If a free society is to be preserved, seven elements of personal character must be dominant in its citizenry; namely, self-reliance, individual initiative, personal responsibility, thrift, pride of citizenship, courage, and religious faith. In recent years, spurious substitutes have been palmed off on the American people for these basic virtues of free men: Government aid for self-reliance; collectivism for individual initiative; a partly socialized economy for personal responsibility; public subsidies for thrift; subservience for pride of citizenship; paternalism for courage; materialism for religious faith.

Management's Responsibility

To be worthy American citizens, we managers must be constantly on guard to develop and exercise these seven fundamental elements of personal character on which the maintenance of our freedom depends. For history shows that when men attempt to shoulder off their personal responsibilities on to other men calling themselves government, they eventually rear a powerful monster who turns and devours their liberty. The responsibility here is strictly personal. It is you and I as individuals who must assume the task. For we must ever remember that no Chamber of Commerce ever composed a great symphony; no labor union ever painted a great picture; no church ever wrote a great sermon; no management association ever composed a great poem; no government commission ever put together a Gettysburg address. It is the individual, in the last analysis, who determines the course of human affairs.

So when the last clear call comes for you and me, may it be said of us, as it was said so eloquently of Pope Leo XIII at the time of his death:

"Such men fight the campaigns of the future while all the world around them is asleep. But when the time comes, though they, themselves, be gone, the roads they planned are broad and straight for the march of other feet; . . . the spirit they called up still lives to lead. And they, themselves, wherever they may be . . . have a continuing share in the victories that humanize mankind."

A Second Look at Radiographic Inspection of Lead Linings During Fabrication

A year's experience shows that, with gamma-ray inspection, fabricators can produce defect-free, homogeneously bonded lead linings at only a small increase in construction cost

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In a previous paper[1] the author and V. P. Bracken discussed techniques of lead radiography. That paper pointed out that lead defects could be located radiographically. How serious these defects were and if manufacturers were willing and able to produce material without defects was not known.

In the year that has just elapsed, information has been gathered to indicate that the new inspection tool can be used profitably during fabrication of homogeneously bonded lead-lined vessels.

[1] "How Radiographic Inspection of Lead Linings Can Reduce Future Maintenance Costs," by W. Skiba and V. P. Bracken, Mechanical Engineering, vol. 78, March, 1956, pp. 245–247.

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The vessel reported on last year was returned to service after repairs. These repairs were based on radiographs taken at that time. Soon afterward, additional lead failures occurred. When these failures were correlated with available radiographs, it was found that they occurred where imperfections were indicated on the film. These imperfections were originally classified as relatively minor in nature. Knowing that the lead lining of the vessel contained too large a number of such defects to permit economical repairs, the decision was made to obtain a new vessel. During the fabrication of this new 8-ft × 36-ft homogeneously bonded lead-lined vessel, radiographic inspection was utilized.

Acceptance standards for this new inspection technique were formulated at this time.

Fig. 1 Steel plate being heated on furnace after pickling the lining side and fluxing, and prior to application of "first coat"

Fig. 2 Chipping of excess lead to remove foreign matter. Lead is poured to a double thickness to float impurities.

Fig. 3 Flame washing of lead surface to flatten surface, check for inclusions, and repair minor defects

Fig. 4 Peening of lead surface. Peening results in a more dense and reduced-grain-size lead structure.

Specifications

A purchase specification was written specifying lead radiography meeting the technique requirements of the API-ASME Code "Procedure for Radiographic Examination of Welded Joints."[2] The specification also stated that defects such as laminations, inclusions, mill scale, gas pockets, rust particles, dross, or foreign materials of any kind were not permitted in the lead.

Bids were submitted by fabricators of this type of equipment. One fabricator agreed to comply with the requirements of lead radiographs and continuous fabrication inspection by the purchaser. Techniques developed and used over a period of years were utilized by the vendor during fabrication of the vessel. No attempts were made to vary from his procedures, which will now be described.

Fabrication

Initially the plates to be bonded were pickled on the lining side, fluxed, and then placed on a furnace as shown in Fig. 1. Then heating of the plate began.

Application of the "first coat" was made by the rubbing of bar lead on the hot steel. After the entire sheet had been coated in this manner, molten lead was added until twice the finished thickness was attained. The entire lead and steel assembly was then allowed to cool.

Lead was poured to a double thickness in an attempt to float impurities. This excess thickness with included foreign matter was then removed as shown in Fig. 2. The removal of this extra thickness resulted in a rough surface. Flame-washing of the chipped surface served two purposes, namely, smoothing and flattening of the areas, and checking for, removing, and repairing minor defects. This operation and the following step of peening are shown in Figs. 3 and 4. Peening resulted in a more dense and reduced-grain-size lead structure.

[2] API-ASME Code, Unfired Pressure Vessels for Petroleum Liquids and Gases, Fifth Edition, 1951, Section W 524, Pars. d, e, f, i, j, k, and l.

At this stage of fabrication before the lead-bonded steel was rolled to vessel diameter, the new inspection tool was applied. Normal gamma-ray exposure techniques were utilized, with proper allowance for the $^3/_8$-in. lead thickness in the exposure time.

After the lined sheets were rolled and welded together the $2^1/_2$-in. steel strip on either side of the weld was lead-lined by hand burning. This area also was inspected by radiography.

During the period that the steel plates were being lined, the attachments were lined as shown in Figs. 5, 6, and 7. These were then welded to the vessel and finished off as in Fig. 8. The nozzle necks and areas under reinforcing pads were radiographed after all lead work was completed.

No tin or antimony was used in this process of bonding lead to steel. Chemically pure lead was used in all fabrication.

Radiographic Technique

All radiographs were made with a 100-mc Cobalt 60 source and fine-grain high-speed film. Source film distance was held at 12 in. for exposure on plate steel and the source was placed on the nozzle center line when attachment radiographs were exposed. The short distances involved resulted in maximum exposure times of 2 hr. In all cases the radiographic requirement of 2 per cent sensitivity was met. For making exposure estimates using the Cobalt 60 source, a steel equivalence factor of 2 in. for 1 in. of lead is used. This factor is then added to the thickness for steel plate of the vessel shell. The total equivalent steel thickness can be used in any of the normal methods available for calculating Cobalt 60 gamma-ray exposures for steel.

Film Interpretation

Film interpretation is not difficult. Very dark sharp markings are indicative of pin holes, gas pockets, or

Fig. 5 Application of "first coat" of nozzle by means of hand torch and lead bar

Fig. 6 Pouring of lead for lining of nozzle. Core and nozzle neck were heated to temperature with hand torch.

Fig. 7 Puddling of the nozzle lining in order to float up inclusions and gas pockets

foreign-material inclusions. Uniform general shading of the film may be due to changes in lead thickness; however, if it begins or ends in a sharp line it warrants investigation. Dendritic or featherlike markings are indications of slag or dross and should be removed. This latter type of marking also indicates lack of bond between lead and steel. Photographs and radiographs of actual lead failures are portrayed in the original paper on lead radiography.[1]

Cost of Inspection

Radiography of this vessel was carried out on a randomized basis with respect to the shell and heads. The nozzle necks were all radiographed 100 per cent. The cost of doing this inspection was $5\frac{1}{2}$ per cent of the vessel fabrication cost. The expense of radiography for 100 per cent of the vessel surface area would equal 10 per cent of the vessel fabrication cost. This is a small premium to pay for an item that can result in avoiding process-unit down times.

Fig. 8 Bonding of lead under nozzle reinforcing pad after welding attachment to shell and completing the lining of nozzle

Conclusion

Present techniques for inspecting lead linings are inadequate for locating all defects. Based on the results of the radiographic technique, the radiographs provide a sensitive positive tool for locating defects in lead linings and also provide permanent records for future reference.

Original investigative work presented a film-interpretation problem owing to the lack of knowledge of lead work and lead radiography. The first radiographs contained excessive amounts of markings, and it was thought that probably all lead work was of this nature. The results of the second and latest investigation show that lead work can be produced with no defects whatsoever and at little increase in fabrication cost to the purchaser.

Lead-lined vessels do not have to be radiographed 100 per cent. Radiography done on a quality-control basis should be sufficient to guarantee a level of quality that would be acceptable to the purchaser. Spot checks would be made to determine if correct procedures were being followed by the fabricator. The cost is small when considering the reduction in unit down time that can be realized.

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Proposed Survey of the Engineering Profession

Report of the Joint Committee of the Engineers' Council for Professional Development and the Engineers Joint Council

THE ever-accelerating pace at which expanding scientific knowledge and discovery are rendered useful by the engineer has stimulated a world-wide revolution. By force of momentous advances that are still in progress, the engineering profession has assumed broad responsibilities, among which its traditional concern with individual professional competence is only one. The engineering profession today is the most complex of all professions. The present shortage in engineering manpower, serious enough by itself, has served further to underscore many other major problems confronting the profession. It has raised more questions than have been answered.

Critical problems have arisen in every facet of the profession: Education, utilization of manpower, organization, and social and economic factors, all of which intimately concern the national welfare. It therefore seems appropriate, necessary, and, in fact, urgent that the engineering profession at this time make the first searching and comprehensive self-study in its history.

If it were a matter of numbers alone, the engineering profession and the nation would face a somewhat less formidable problem. But the pattern of the future is already being drawn in the affairs of today. Society and technology have not only utilized the professional competence of the engineer, they look to him to supply managerial and executive ability as well. To cite just one example, answers to the problem of natural resources will almost certainly hinge on the decisions and accomplishments of engineers. The engineer often works without the spur of public concern that, for example, accompanies medical research. More than ever, today, the engineer must possess the technical and intellectual discernment to anticipate problems and solve them almost before others think of them. Inevitably, engineers make policy in a host of industries and vast government agencies which a decade or two ago looked to the corporation lawyer, the financier, or a political figure for the lead. Just as inevitably, in a period when the battle between freedom and totalitarianism is waged with bread and know-how, national policy must be drafted with the aid of engineers.

The Time Is Now

The decision toward an undertaking so immense as a survey of the nation's largest profession is not easy, and ought not to be made with undue haste. Five years of informal and formal deliberation and introspection lie behind this call for the survey. It is issued not only because the time is propitious, but also in the belief that delay will do injury to the living and to generations to come. Action born of crisis can be precipitous; but if that action springs from competence, integrity, and authority, it is likely to lead to vast strides forward.

Among the great professions, engineering may take justifiable pride in its reputation. It has been uniquely free of mistrust, scandal, ridicule, and charges of incompetence or inertia. Having earned universal respect, the profession must not complacently assume that this is a permanent grant. If in the future shortcomings should bring deserved criticism upon the profession (to say nothing of abuse and threats to professional freedoms) it will have only itself to blame.

To measure up to the tasks required of it, the profession must be assured that it is properly training, utilizing, rewarding, and attracting men of the highest competence and potentialities. Only a top-to-bottom survey can determine the nature of the mission, the extent to which it is being fulfilled, and the steps necessary to maximize our efforts in the most effective manner.

Personality of the Profession

The profession is composed of individuals. The danger that this will be forgotten grows as the proportion of engineers to other groups increases inexorably. Indeed, neglect of the individual has always been a tendency in a profession distinguished from many others by the fact that most of its members are employees rather than self-employed. Despite emphasis on quantity, society and technology now clearly demand of engineers a high order of intellectual capability, individuality, imagination, and ability to assume responsibility. The survey must therefore probe not only the day-to-day tasks of the engineer but also his attitudes, hopes, ambitions, disappointments, and fears.

Spirit of the Survey

Other professions have surveyed themselves thoroughly, under less pressing circumstances than those which face the engineering profession today. The two most recent studies yielded significant pictures of the American architect and the American lawyer. Engineering's needs seem to call for a type of investigation more akin to the Hoover Commission's study on governmental operations.

Scope and Uses of the Survey

In each of the great areas, the survey will:

Seek comprehensive knowledge of the facts of the existing situation.

Formulate answers to many penetrating questions arising from the facts.

Make recommendations for future action.

Provide ways and means of putting the recommendations into actual practice.

If it truly penetrates every aspect and level of engineering, the survey's constructive conclusions may well be expected to provide guides for the profession for the next quarter-century. Not that engineering should straight-jacket itself, for it is by nature dynamic and changing. But the great problems this survey will

attack are of a kind that not only will remain with us for the next generation, but may be expected to come into sharper focus and carry even greater significance.

Following are the areas with which the survey must be concerned, together with an indication, not intended to be complete, of questions in each area that cry for investigation and solution:

Professional Services and Responsibilities. Today the essential of individual technical competence is but a starting point of the engineer's role in society. Past concepts, performance, and evolution of the profession should be analyzed to obtain an up-to-date perspective on present and future problems. Therefore:

What are the strictly professional responsibilities of the engineer?

To what extent do engineers influence the application of their professional efforts?

How effective are the various codes of professional ethics?

What are the gaps in intellectual leadership that could be, and should be, filled by engineers?

To what extent should professional education and organization be altered to equip the engineer for new, untraditional services and responsibilities?

The Supply of Brain Power. To meet the spiraling demands for both capital and consumer goods, the productivity of human effort must be rendered increasingly more effective. At the same time the intricacies and refinements of modern production take a growing percentage of engineering man-hours from inception of an idea to the fabrication and assembly. For example, a 1940 fighter plane took 17,000 man-hours of engineering, a 1955 took 1,410,000, and a 1960 promises to take 2 million. Engineering must share with the other professions and intellectual occupations a relatively small reservoir of talented youths. Of the mere 17 per cent of high-school graduates intellectually suited to engineering education, engineering colleges are drawing one fourth of the male portion. A single profession enlisting so great a proportion of this precious human resource assumes grave obligations. Therefore:

From a completely objective and unemotional study, what are the specific shortages, present and projected? Careful statistical studies should deal not alone with the over-all situation but with industries, branches of engineering, and professional levels (consulting, industrial, teaching, and research).

What are the demands of the other professions on the national supply of brain power? Will these brains have to be rationed? If so, what should be the order of priority?

In general terms, and in case studies, how are engineers utilized?

Depending on the specific shortages disclosed, how can they be alleviated: by regimentation, incentives, better utilization, changes in education, variation of standards, or by other means?

If the growing concentration of numbers in this one profession tends to depress the morale and initiative of its members, how may this be remedied?

The Individual Engineer. Because he often works in teams and is usually an employee, the individual engineer is too often anonymous. The tributes he has earned are frequently paid to his profession in the mass. Therefore:

What is an engineer? Who is he, and what are his origins and his social, cultural, and economic background? For the purposes of outlining an operable framework for the survey, the Survey Committee must first establish a definition of who shall be termed "an engineer" and therefore be included in the study. To do this, the areas of activity of engineers and those of scientists must be delineated.

Why did he choose engineering? What was the nature of his intellectual preparation, and how did it affect his subsequent career?

What made him choose his particular branch or level of engineering?

How much does he earn and how much can he expect to earn throughout his career? What are his living standards?

What are his personality traits, and how do they affect his professional performance?

Does the fact that so many engineers are employees adversely affect their professional outlook? Is there a different outlook among those who are self-employed or in policy-making positions?

What are his intimate feelings about his profession, about the organizational pattern in which he functions? How does this pattern encourage or discourage his individual talents, initiative, and imagination?

What do his employers and nonprofessional colleagues, family, and friends think of him? How does he rate in his community or in the business world compared with members of other professions?

All other factors being equal, is he more valuable for having remained in one job for many years or having switched often?

What are the effects of pension systems, and other devices to make employment more attractive and reduce turnover, on the freedom and development of the individual engineer?

Does he attempt to advance himself after he leaves college, and by what means?

Does he have nonprofessional interests, in individual pursuits and in his community?

Subprofessional Engineering Services. Like the brain in the central nervous system, the engineer triggers activity by men and women in a greater number of allied occupations and skills; at the same time, he receives information and services from them in order to perform the tasks requiring his particular professional ability and judgment. This is true of other professions, though their allied subprofessional services seem to be more thoroughly and rationally organized. It is ludicrous to imagine a cardiologist or other medical specialist performing the functions of a nurse, an x-ray technician, or a bacteriological aide. Yet many professional engineers are found in comparable situations. Therefore:

What are the specific types of subprofessional services allied to professional engineering? Should more women as well as men be enlisted into them?

To what extent are professional engineers engaged in them?

What are the educational requirements for subprofessional services? What are the existing and needed educational facilities for them?

What kind of people should be attracted to these services?

What recognition can be given them? What opportunities should they have for transfer to professional status?

What mechanical, as well as human, aids are given to the engineer?

To what extent can expanded and better apportioned subprofessional activities alleviate shortages in the profession?

Engineering Education. The ink is scarcely dry on the last extensive survey of engineering education. More spadework having been done in this area than in any other aspect of the engineering profession, the job of the survey will be to crystallize the basic problems of engineering education as they relate to other areas of the survey and

to make comprehensive, detailed, and realistic recommendations for solutions. Among the following questions, the survey will have considerable information on some, may choose to examine others in still greater detail, and may want to put others to thorough examination by eminent laymen as well as by engineers:

What do we mean by engineering education?

What is the contribution of the educational system to the development of the professional engineer from secondary school through postgraduate study?

Is engineering education too formal, stereotyped, and rigid? Does it foster or inhibit originality and creativity?

What is the actual cost of educating an engineer? How is it paid?

How are engineering schools financed, staffed, and equipped?

What is the composition, ability, and morale of engineering faculties? How may schools retain outstanding faculties in the face of competition from other areas?

What are the causes and implications of the heavy mortality in engineering students?

To what extent should social and humanistic studies be effectively integrated into engineering education?

Should some engineering studies be introduced into educational programs for other professions?

How far should formal graduate work go? Who should pursue it?

To what extent are the advancement and utilization of older engineers (those out of college five years or more) impeded by lack of opportunity or incentive for keeping abreast of new advances in engineering and science?

What procedures can encourage continuing education stimulating to the engineer, not restrictive of his family life and finances, and advantageous to his employer?

Registration and Unionization. Compared to his invaluable contributions and widespread prestige, the legal status of the engineer and his personal relationship with his profession lag far behind and are relatively ambiguous. The fact that 48 states have registration laws fails to meet the hard truth that while a doctor is a doctor, a lawyer a lawyer, a minister a minister, too often an engineer is all things to all men. Of all the professions, engineering has the most members of labor unions. Therefore:

Should mandatory licensing be expanded? Should engineers be licensed broadly or in particular fields?

Why do engineers register or not register?

Has registration improved engineering ethics and the level of engineering services to the public?

What problems arise from the practice of engineering through the corporate form of business?

What are the nature and extent of unionization?

Why do engineers join unions? How does union membership affect their professional competence and subsequent careers?

What is the organized profession's attitude toward unionization?

Are there advantages and disadvantages in unionization that affect the profession's role in society?

Organization of the Profession. Many societies, organized along branch lines, flourish within the engineering profession. The societies are organized in two federations. The profession has no true counterpart to the American Medical Association and the American Bar Association. On the other hand, those national organizations are comparatively new institutions in the history of their professions and their function and value, if related to the survey of engineering, should be studied rationally and objectively. Therefore:

For meaningful organizational purposes, what are the major branches of engineering?

Is the engineering profession cohesive?

What is professional unity and how does it affect maximum professional service?

Are changes in the organization of the engineering profession desirable?

What is the political, social, and economic status of the profession?

What are its relationships to scientific organizations, industrial associations, labor and political organizations, the military, and other professional organizations?

Role of the Societies. A survey of the engineering profession will require at least two years. It will cost on the order of $1 million.

The details of organization and procedure of the survey clearly cannot be spelled out in advance. For one thing, they require long and careful planning. For another, they demand a plan for consultation with all of the constituent societies, a step requiring that the societies first endorse this proposal in general terms.

Generally, however, this Joint Committee suggests the establishment of a Committee on the Survey of the Engineering Profession jointly under ECPD and EJC.

Following the lead of recent self-studies by other professions, it seems logical to organize the survey so that various groups would investigate specific items on which they are best qualified. Such groups need not be composed solely of engineers since engineering embraces a spectrum of activities much broader than the technical competence of the individual engineer. The caliber and distinction of the directing committee should be of a level to arouse enthusiasm and support in areas outside as well as within the profession. The committee would:

Outline a form of organization to conduct the survey, using the present proposal and supplementary suggestions from the constituent societies as a basis. It will doubtless be desirable to explore the extent to which one or another problem is peculiar to a given segment of the profession, so that special groups in one or more constituent societies may become special agents of the committee.

Appoint a director and small staff to assist in detailing the program and later administering it under the committee's auspices.

Make progress reports to the executive committee of ECPD and the Board of Directors of EJC, so that constituent societies may be continuously informed through their representatives.

Manifestly, the survey cannot and should not be undertaken without the enthusiastic endorsement and support of the national engineering societies. The unity of the profession on the desirability of the survey must be unmistakable before others are asked to support it.

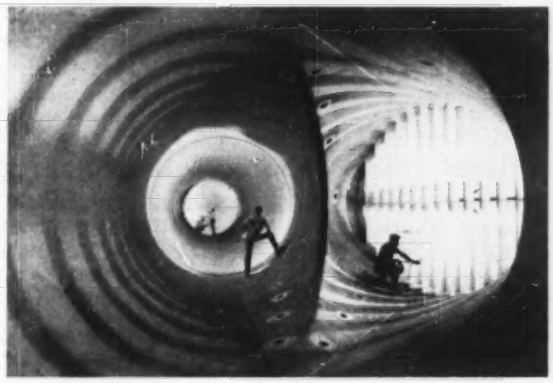
The Reason Within Us

The future pattern of engineering will, to an extent undreamed of by many, influence day-to-day schedules in factories and mines, the size and shape of the national product, the face of the city and countryside, conditions in homes here and abroad, and the respect with which American words are heard at conference tables the world over. This is verified by historical and technological reality and by a sense of great works—wonders, if you will—that lies somewhere in the traditionally unemotional engineer. It is the preservation and extension of that sense that we cite as our final reason for the survey of the engineering profession.

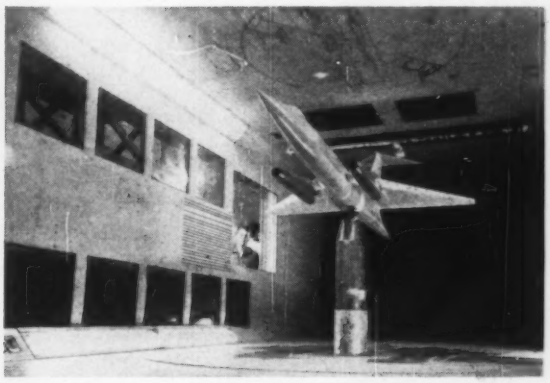
Briefing the Record

Abstracts and Comments Based on Current Periodicals and Events

J. J. Jaklitsch, Jr., *Acting Editor*



Shadow patterns mark the juncture of these air passages leading to the two test sections of the new Unitary Plan Supersonic Wind Tunnel at Langley. Guide vanes help turn the air smoothly as it returns from the two test areas, both of which use the same drive system. Studies may be made in the $15,500,000 wind tunnel at velocities ranging from 1.5 to 5 times the speed of sound—approximately 1100 to 3800 mph at sea level.



This high-speed research model was fabricated at the NACA Langley Aeronautical Laboratory for special studies in the 300-mph 7 × 10-ft wind tunnel. NACA scientists are using the model to evaluate stability characteristics in subsonic flight, including the take-off and landing approach of an airplane capable of high speeds. An NACA scientist is shown outside the test section observing the model, which is supported by a single vertical strut.

Langley Aeronautical Laboratory

How NACA uses rockets, planes, hot jets, and new devices in research of aerodynamic heating problems was discussed by scientists of the National Advisory Committee for Aeronautics at the recent Triennial Inspection of the NACA Langley Aeronautical Laboratory, Langley Field, Va.

Four-stage rockets zooming higher than 200 miles above the earth, supersonic air jets hotter than a blast furnace, aircraft with wings only inches thick, light-gas guns capable of 13,000-mph speeds, quick-heating quick-cooling quartz lamps—these are some of the devices being used in the massive research program on the problems of aerodynamic heating at the extremely high speeds of tomorrow's aircraft and missiles.

In the push for higher and higher speeds, the problem of surface heating of the aircraft or missile grows as the speed increases. That is why NACA research scientists have put massive effort into research of both the heating problems and the tools to do the work.

Although other problems are encountered in design of the ballistic missile, the heating problem is of overwhelming importance, since temperatures generated on the skin can become hotter than the surface of the sun. In manned aircraft, the problem of keeping the pilot and equipment cool enough is even more severe. NACA scientists pointed out that present-day fighter planes are at the threshold of serious heating difficulties, inasmuch as the temperature due to aerodynamic heating can rise as much as 300 F at only twice the speed of sound. At three times the speed of sound, 2000 mph at high altitude, the temperature would be about 660 F.

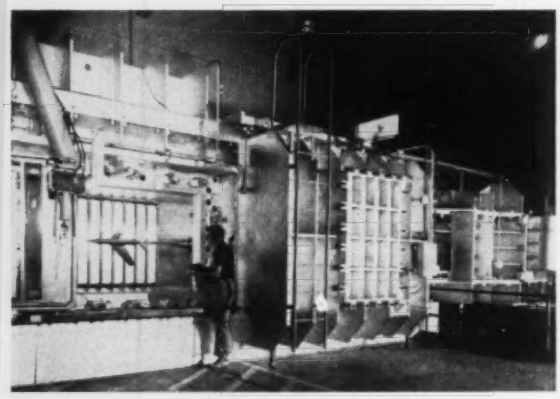
NACA's fast, high-flying rockets, fired from the Pilotless Aircraft Research Station at Wallops Island, Va., carry aloft scale models of aircraft missiles and components. Research data vital in design of full-scale vehicles are telemetered from rocket to ground by instruments carried aloft in the device. The rockets, composed of single-stage or in combinations up to four, provide information often impossible to obtain by any other means.

NACA speakers said the highest speed reached by one of the four-stage models was Mach 10.4, or 6864 mph. The topmost stage went over 1,000,000 ft above the launching site on the shore of the Atlantic.

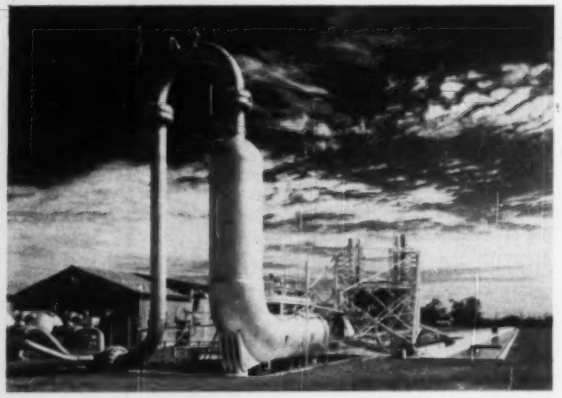
Also operated under Langley's Pilotless Aircraft Research Division are "hot jet" combustion products tunnels, one of which utilizes gases issuing from a $2^1/_2$-in. rocket engine. The jet speeds at 4750 mph and provides temperatures above 4100 F to simulate conditions of high-speed, high-altitude flight. The other combustion products tunnel makes use of high-pressure air which is heated to 3500 F by burning ethylene gas in a combustion chamber, at speeds to 1300 mph.

A special light-gas gun capable of speeds to Mach 20 has been constructed at the NACA Ames Laboratory. A small magnesium model fired in this device at 11,000 mph for a brief period of time became hot enough to ignite the metal model.

Special research airplanes are being flown by NACA



A scale model of the Bell X-2 research airplane is shown installed for calibration tests in one of two test sections of Langley's new Unitary Plan Supersonic Wind Tunnel. An NACA technician checks the model before closing off the test section, which is 4 ft wide, 4 ft high, and 7 ft long. The tunnel is controlled from a soundproof glass-enclosed station in the upper background.



A carriage catapulted by a hydraulic jet at speeds up to 150 mph for studies of ground loads on aircraft in landing is in operation at Langley. A drop-test rig is installed on the carriage (*right*), which is catapulted 400 ft in 3.5 sec along a 2200-ft track. Special instruments record load data as the landing gear or other item under test is dropped on a concrete strip.

pilots from its High Speed Flight Station, Edwards, Calif., to investigate the heating phenomena at speeds between two and three times the speed of sound. Despite the crash of the Bell X-2 which killed an Air Force pilot, the research plane program is being extended by use of the X-1B and X-1E. The wing of the latter plane has a thickness only 4 per cent of its chord. Under construction by North American Aviation is the X-15, designed to fly faster and higher than man has ever ventured. The "flying laboratory" series is a joint program of NACA, the military services, and the aircraft industry.

The Langley Laboratory, for several years, has been using supersonic air jets to simulate heating and loads on aircraft at hypersonic speeds, but the need has become apparent for much larger jets. One NACA jet is supplied with air heated to 1000 F at 3000 psi. Another apparatus, made from two 6-in. Navy guns, is a free-piston compressor able to compress air to temperatures of several thousand degrees.

Still another heating device, used for study of structures, is a carbon rod-heat radiator. Although of limited usefulness, it is capable of high rates of heating to a maximum of 4700 F. A more advanced type of heat radiator utilizes quartz tube lamps capable of very rapid heating and cooling such as would be experienced by a missile re-entering the earth's atmosphere at hypersonic speed.

The new Langley supersonic blow-down wind tunnel, slated for operation next year, will enable NACA scientists to test structural components under conditions of aerodynamic heating and loading in a test section 6 ft high $\times$ $8^{3}/_{4}$ ft wide, at speeds between Mach 2 and 3.

National Carbon Laboratory Dedicated

THE new Parma, Ohio, research laboratory of National Carbon Company, a Division of Union Carbide and Carbon Corporation, was dedicated Sept. 18, 1956. Designed primarily for basic research in chemical and solid state physics, the multimillion dollar laboratory brings to seven the number of major research centers operated by divisions of Union Carbide and Carbon Corporation, which in 1955 spent approximately $43 million on research.

The new laboratory facilities are already in operation, with research scientists studying ways to improve existing materials and, more importantly, methods to create new materials for the metal, electronic, power, chemical, and electrochemical industries.

During the dedication ceremonies two significant scientific achievements were announced.

Dr. Robert G. Breckenridge, director of the laboratories, said that National Carbon scientists have discovered for the first time in history how to "weld" pieces of graphite together, providing a new technique which promises advances in processing materials for the atomic age.

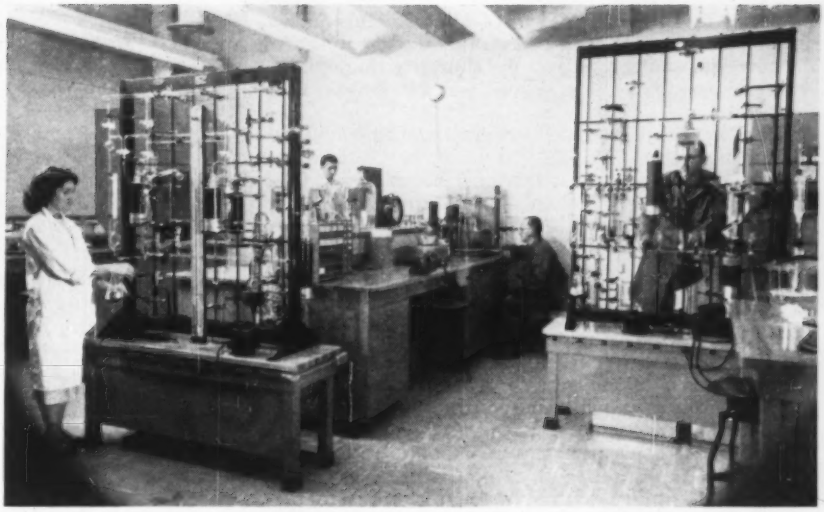
In addition, he said that the largest single crystals of cadmium sulphide ever reported have been "grown" in the new laboratories. A light-sensitive material, cadmium sulphide can be used in photo cells, solar batteries, and when properly activated, as a light-producing phosphorescent material.

"As part of an extensive research program in the field of semiconductors, we have been working with single crystals of cadmium sulphide," Dr. Breckenridge pointed out. "It has been found that the photo-conducting properties of single crystals are superior to those of a polycrystalline film, and laboratory crystals $^{3}/_{8}$ in. in diam and several inches long have been produced by newly developed techniques."

"Heated in special crucibles under high pressure to prevent vaporization, liquid cadmium sulphide is allowed to cool slowly. As it cools, a single crystal emerges, and takes its shape and size from the crucible."

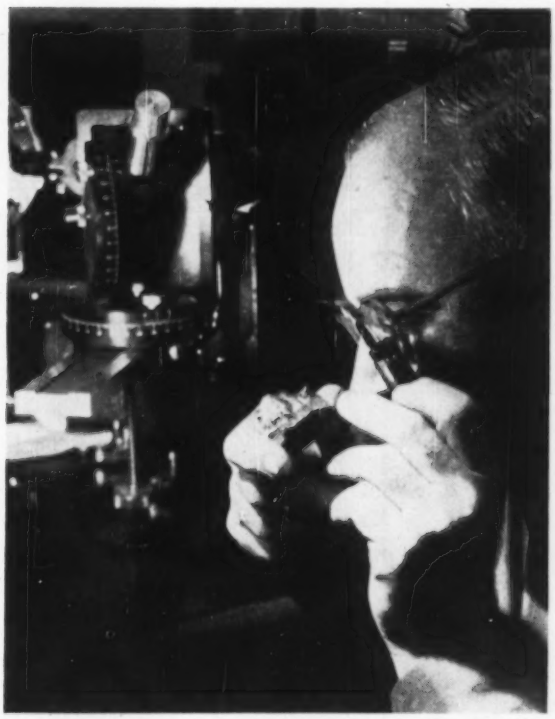
Researchers at the laboratory, he said, are concentrating primarily on the fields of chemical and solid state physics, electrochemistry, carbon and graphite and high-temperature refractory compounds.

Pointing out the significance of welded graphite, Dr. Breckenridge said that it suggests the possibility of prefabricating sheets and panels for the assembly of



Typical of some 158 similar units is this research module at Union Carbide's new Parma, Ohio, laboratories. Each module is equipped with the scientific equipment necessary to carry out experiments in the particular field being studied and is serviced with a wide variety of electrical voltages and gases. Movable metal partitions make it possible to rearrange individual research modules as required.

nuclear reactor moderators which now must be built up from graphite blocks. Graphite is an essential material in nuclear reactors because of its neutron-slowing abilities which makes possible the self-sustaining chain reaction necessary in harnessing nuclear energy.



The line between the shiny and dull regions in this piece of graphite is the place where two pieces were "welded" together at Union Carbide's new research laboratories, managed by its National Carbon Division. The graphite in the vicinity of the weld is very crystalline and of high quality.

Explaining the background of research efforts to melt graphite, Dr. Breckenridge said:

"Melting operations are used in well-known techniques for processing metals. In the case of graphite, which is one of the crystalline forms of carbon, however, it is not as simple. This is so because at normal pressures graphite does not melt when heated to high temperatures, but instead vaporizes directly into a gas. If heated under high pressure, however, vaporization is prevented and graphite can be made to melt. This is the key to the process."

Already this technique has led to the production of new forms of graphite which have a much higher degree of crystalline perfection than any artificial graphite obtainable up to now, according to Dr. Breckenridge. In addition it has led to a method for welding pieces of graphite together, this being essentially a melting operation.

"Pieces of graphite to be joined together are placed in an atmosphere of the inert gas argon under high pressure," he reported. "The pieces are brought into contact and a direct current is passed through them. The pieces are then separated slightly, creating an arc that heats the graphite to extremely high temperatures. This combination of heat and pressure melts the graphite and the pieces are welded together."

A similar technique is used for a sort of continuous-casting process, in which comparatively large pieces of graphite are formed from the liquid state, he pointed out. This graphite has a degree of crystalline perfection comparable with that of the best natural graphite, formed millions of years ago in the great furnaces of nature.

"This is just one part of a broad program which has led to the production of other scientifically and technologically interesting forms of graphite," Dr. Breckenridge said. "For example, we have produced very fine filaments, resembling whiskers, having diameters smaller than $^{1}/_{10,000}$ in. These filaments have exceptional tensile strength, perhaps as much as ten times that of normal carbon materials, and ability to withstand severe plastic distortion without breaking."

In his dedication address, "The New Requirements on Education Imposed by Our Advancing Technology,"

Dr. James R. Killian, President of Massachusetts Institute of Technology, decried the fact that too few students are now studying to become metallurgists, biologists, geologists, aeronautical engineers, mathematicians, and chemists.

"If industry is to have the personnel to man its multiplying laboratories," he said, "if it is to have the talent to handle the increasing operational complexities imposed by modern technology, our educational system must grow and improve in proportion to the growth and advance of industry. In fact, it should be a step ahead."

"I suggest," Dr. Killian continued, "the importance of both industry and the universities seeking new patterns of liaison between the fundamental research activities of the university and the more directed, committed research of industry so that cross-fertilization may be encouraged while recognizing and protecting the specialized function of each."

National Carbon's new modern laboratories contain approximately 175,000 sq ft of floor space. Designed for extreme flexibility, with provisions for expansion, the main laboratory building consists of 158 laboratory modules or individual research units. Approximately 350 employees including 150 scientific and technical personnel are at work here.

Inertia Dynamometer

WHAT is reported to be the world's largest inertia dynamometer for laboratory testing of full-scale railroad wheels is now in operation at U. S. Steel's Applied Research Laboratory, a division of the new Research Center in Monroeville, Pa.

Standard railroad wheels from 30 to 48 in. in diam can be tested on the machine under normal or exaggerated conditions simulating factors of loading, braking, and tracking encountered in actual service.

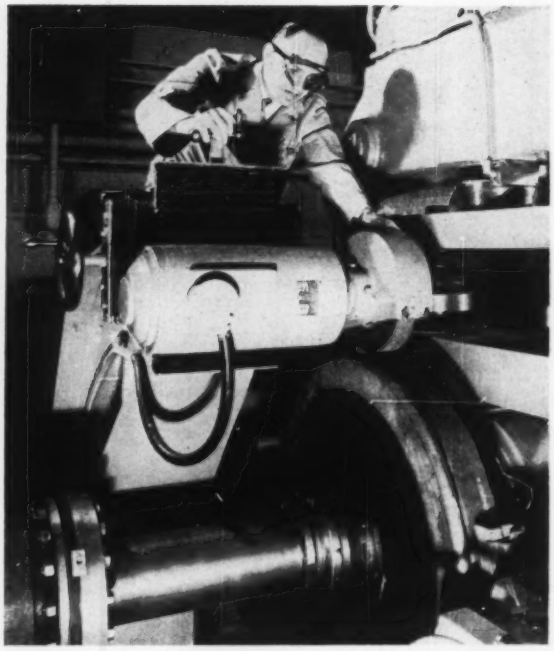
The dynamometer consists principally of a mill-type electric motor, a variable-weight flywheel, a track wheel, a spring-loading device, a braking mechanism, ultramodern instrumentation, and both automatic and manual controls. The entire device, a two-story installation of about 125 tons of steel-reinforced concrete and 100 tons of machinery, rests on a mounting specially designed to reduce vibration to a minimum. The bulk of the installation is below ground.

The direct-current, mill-type electric motor has a power output up to 450 hp. It can be rotated at various controlled speeds up to 1500 rpm. This is equivalent to 161 mph on a 36-in-diam wheel. Deceleration as well as acceleration rates can be closely controlled.

The new dynamometer is a completely integrated unit. Direct current is supplied by a 250-kw motor generator with a 200 per cent overload rating. Auxiliary units supply forced lubrication, hydraulic pressure, and pneumatic pressure.

The variable-weight flywheel is made up of a series of removable disks that fit on a tapered shaft and are bolted to each other. With all 14 disks in place, the motor will bring the dynamometer up to top speed in less than six minutes. When rotating at top speed, a maximum energy of 68,500,000 ft-lb can be imparted to the test wheel.

With such high kinetic-energy levels available, tests may be conducted at more than twice the levels encountered in modern railroad service. For example, each 40-in-diam wheel under the largest present-day diesel locomotives carries a static load of about 30,000 lb. If the locomotive is traveling at a top speed of 120 mph, in braking to a stop, each wheel must dissipate about 15,000,000 ft-lb of energy. A 40-in-diam wheel being tested on the dynamometer at a speed equivalent to 120 mph can be given an energy potential of 30,000,000-ft-lb.



World's largest inertia dynamometer for testing full-scale railroad wheels is installed at U. S. Steel's Applied Research Laboratory in Monroeville, Pa. A laboratory technician is shown adjusting the heavy grinder for dressing the tread on a wheel to be tested.

A unique feature of the new machine is the ability to simulate the loading and tracking of a wheel on a rail. A 9-ft-diam track wheel with the head of a standard 132-lb rail around the periphery is rotated by frictional contact with the test wheel. Radial loads up to 40,000 lb can be imposed on the journal of the test-wheel axle through a special bearing. The same bending moment and the same wheel-rail contact pressures that are encountered in actual service may be produced on the test wheel.

To duplicate the tracking of a wheel in service, the 9-ft-diam track wheel can be oscillated laterally as much as $2\frac{1}{2}$ in. at rates up to 60 cpm. The action of wheels on curved track can be reproduced by lateral movement of the track wheel. In this fashion, thrust loads up to 15,000 lb can be imposed on the flange of the test wheel.

The dynamometer can also be used for fatigue testing of standard railroad axles. Full-scale axles of various sizes from 4 to 10 in. in diam can be mounted in the machine in place of the test-wheel axle and loaded as a rotating cantilever.

The new installation will be used not for quality control but as a research tool for the development of railroad wheels of improved composition and mechanical design.

Closed Circuit Test Loop

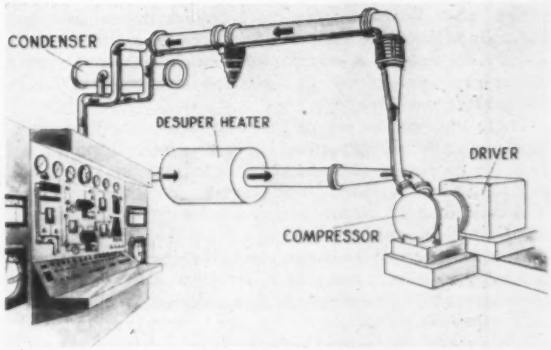
After two years of planning and assembly of components, Worthington Corporation of Harrison, N. J., has recently completed the construction of a new test loop for research and development work on refrigeration compressors of many types. It is an automatic, spray desuperheating, closed system.

The new system has been used to test various centrifugal refrigeration compressors for commercial applications ranging from subzero process chilling to water chilling for central-station air conditioning. It has met the company's objectives of being able to test compressors over a wide range of simulated field conditions.

Worthington manufactures standardized lines of centrifugal compressors for refrigeration, and custom-engineered lines for industrial applications including process refrigeration. The new test loop was designed to test all these compressors with various commonly used refrigerants.

The product attainment objectives through the use of the new loop point to high efficiency, low noise level, wide range of cooling load, mechanical dependability, and simplicity of operation. In obtaining these objectives, the new test loop may be compared to a wind tunnel, except that it uses a refrigerant (gas) instead of air. An electronic computer reduces to workable figures the data received from the loop instrumentation.

By use of the loop, actual operating conditions are set up simulating field conditions so that in a short time engineers can see the performance of the machines being tested in the laboratory, over a far wider scope of conditions than could be attainable in the field.

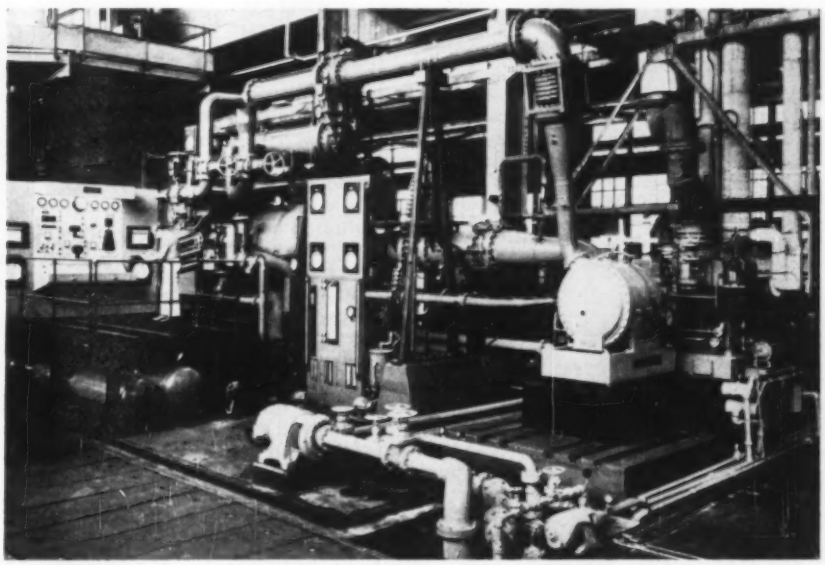


Schematic diagram of the new closed circuit test loop for research and development work on centrifugal refrigeration compressors. Arrows indicate gas (refrigerant).

The centrifugal compressor has often been described as "the heart of a refrigeration system." It compresses the refrigerant within the system from a low pressure and temperature level, where heat is absorbed by the refrigerant, to a higher pressure and temperature level so that the heat may be rejected to the atmosphere. The new test loop causes the compressor to function in this same manner; however, no heat is added at the low-temperature level and only the heat of compression must be removed from the gas at the high-temperature and pressure level.

The compressor to be tested is mounted on a base and connected to the driver (steam turbine). After starting, automatic control systems come into play to bring the compressor to a prescribed set of operating conditions, which would be encountered were the compressor part of an installation in an industrial plant or office building. Flow, pressure, temperature, power consumption, etc., are measured and fed into an electronic computer which translates the figures into useful performance characteristics.

In the past, test data were obtained from field and shop tests conducted on central-station refrigeration systems. Testing in refrigeration systems has a primary disadvantage in the fact that compressor performance cannot often be determined independently of system performance, a lack of control of test fluid properties, and a lack of rapid test-system response.



Over-all view of new test loop in Worthington Corporation's Research and Development laboratory. Compressor being tested appears at *right*. It is driven by a Worthington steam turbine, behind the compressor. Centralized control panel, at *left*, with instruments, permits operator to obtain quick readings of flow, pressure, power consumption, etc., at each test point.

The new Worthington research facility overcomes these handicaps because the compressor alone may be tested; the loop can test compressors with all the most commonly used refrigerants because it is automatically controlled.

There has been in recent years an outstanding increase in the use of refrigeration and air conditioning in industrial processes such as those used in the chemical, petroleum, drug, food, and textile industries. There also has been an unprecedented growth in centrifugal refrigeration for air conditioning.

The new loop will be used to test all those giant centrifugal refrigeration compressors vital in many industrial processes and necessary to air-condition factories and multistory buildings.

The system has a graphic control panel from which a single operator can control and obtain the results of a test run.

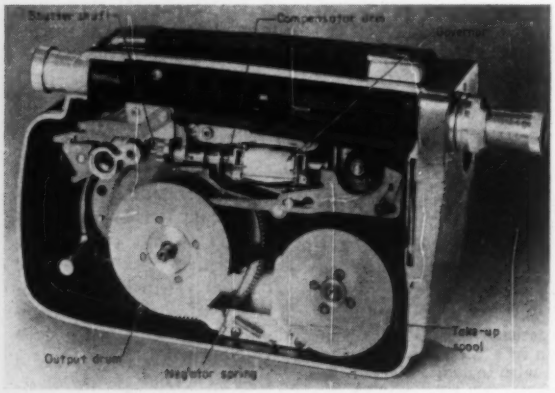
To obtain a test performance curve, an electronic digital computer is used to reduce the test data into final form. Six hundred and three programmed steps are required to completely evaluate the real fluid thermodynamic relationships of the gas and the performance of the compressor being studied. The data received from the loop tests are punched on cards. These cards are fed into the electronic computer along with programmed instructions.

All the calculated performance parameters are tabulated and punched out on result cards which include an 18-digit code so that files can be automatically searched under various categories by punched-card sorting equipment.

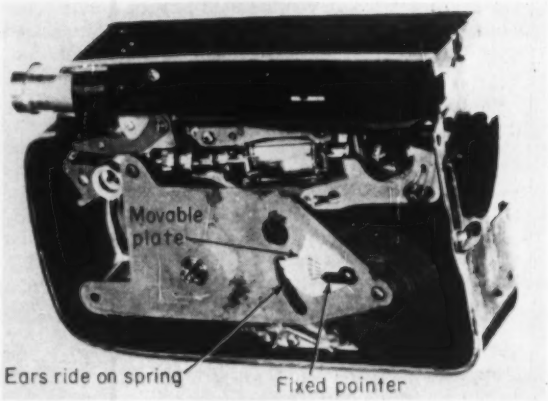
Prestressed Spring Motor

THE first use of the Neg'ator spring motor to power a production motion-picture camera provides longer film footage per wind than a conventional power spring occupying the same space. In Eastman Kodak's 16-mm Cine-Kodak K-100, the unusual spring drives 40 ft of film per wind—100 sec of exposure at normal, 16 frames per sec speed.

The motor, it is claimed, also provides more nearly constant torque, thus eliminating the excessive output peak at full wind and the too-low torque near run down associated with spiral springs. Having no intercoil friction the motor has no tendency to "jump" or "skip"



Internal view of Eastman-Kodak's 16-mm Cine-Kodak K-100



Neg'ator spring is mounted on take-up spool and reverse wound about an output drum

and requires no lubrication. Elimination of lubrication improves low-temperature operation since there is no oil to "freeze." The motor also permits a lower gear ratio—24 to 1 as compared to approximately 150 to 1—between motor and shutter shaft, thus simplifying gearing.

Generally rectangular in over-all space requirement—hence conforming to the design of the camera housing—the motor consists of a coiled Neg'ator band spring of blue tempered steel. Manufactured by the Hunter Spring Company, the spring is 0.0076 in. thick and $^3/_4$ in. wide. It is mounted on a take-up spool and reverse wound about an output drum. At full wind the spring is coiled about the output or power drum. When released it returns to the take-up spool imparting torque to the output drum. Motion of the spring is 460 in.—67 turns on a $1^5/_8$-in-diam power core.

Neg'ator band power units are capable of producing output torques with a uniform gradient throughout run-down. Torque gradients down to, and including zero are possible. In this case a somewhat positive torque gradient is used. Absence of unnecessarily high peak torques eases winding, permits use of less rugged gears, and, since a useful level of torque is available throughout the cycle, full work potential of the spring is utilized.

Constant speed of film and shutter shaft is maintained by a fly-ball governor, assisted by a compensator whose action is controlled by a spring-loaded arm riding the spring coil on the power core.

In addition to the usual film-footage indicator, a spring-motor dial, showing footage still to be exposed before rewinding is required, operates directly from the Neg'ator spring. Ears protruding from behind the movable dial ride on the spring as it passes between spools. The position of this portion of the spring constantly changes, during wind and unwind, with respect to the fixed plate upon which the dial is pivoted. The fixed pointer shows feet of film run remaining before it is necessary to rewind.

Solar Energy

THE American home of the future might be heated, cooled, and lighted by rooftop banks of solar batteries, according to Norman F. Barnes of the General Electric Company's General Engineering Laboratory in Schenec-

tady, N. Y. He pointed out that "with the limited fossil fuels—coal, oil, and natural gas—and even the limited uranium fuels, man is turning to the sun, which, after all, is actually a prodigious nuclear reactor producing vast quantities of energy."

The sun, he added, "pours onto the average housetop in the United States more than a hundred times as much energy as the house receives via the electric power lines."

Mr. Barnes made the statements in an address at the Seattle Industrial Productivity Forum, sponsored jointly by the Seattle City Light Company and the General Electric Company.

Solar furnaces, for example, could produce temperatures as high as 7000 F for metallurgical studies in the quest of alloys of unusual properties, he said.

A solar reflector 33 ft in diam, he added, could be used as a steam generator to produce as much as 100 lb of steam per hr at 100 psi.

Mr. Barnes envisioned housetop solar batteries as flat-plate collectors consisting of one or more layers of glass placed over some good solar-energy absorbing materials, with a space between them.

"The collector is generally a stationary device set at an angle to best receive the sunshine. Air, water, or some other fluid is pumped through the space between the heat absorber and the glass cover.

"The heat absorbing panels also serve as the roof itself. The heated fluid is then used to warm the house, or it can be used to drive some form of heat engine to pump water or perform some other work like cooling the house in summer."

Scientists and engineers, he added, have been fascinated by the idea of making collectors with cheap, "unfabricated" materials such as water or living organisms.

"Plants are able to carry out the process of photosynthesis—that of converting solar radiation into chemical energy, Mr. Barnes said. "While there is still much to be learned about such processes, there may be the future possibility of controlled growing of simple plant forms to convert the energy from the sun."

Mr. Barnes also envisioned a transistorized solar-powered radio receiver. Such a set, he said, would have a solar battery capable of storing enough energy from the sun to power the receiver for 500 hr in total darkness.

Research Rocket

THE first flight of a new, extremely lightweight high-altitude research missile that raced 3800 mph into outer space, obtaining data for use in development of space vehicles, was formally announced by the University of Maryland and Republic Aviation Corporation.

First flight of the new rocket, which is small enough to fit in a family-size station wagon, lasted 5.6 min. In this time, the missile streaked 80 miles up and relayed measurements of primary cosmic radiation, temperatures and spin of the rocket, and acceleration experienced by internal equipment.

The rocket firing was the first of a series of correlated launchings to be made from different areas around the earth to probe the ionosphere, a layer of space above the stratosphere beginning 80 miles up. Data obtained from this and subsequent firings will be used by a group of scientists to formulate an integrated picture of the upper atmosphere.

The scientific value of upper-atmosphere exploration is said to be of considerable importance, not only from the basic research point of view but also to investigate better the regions outside of the atmosphere where the larger rockets, satellites, and eventually manned spaceships will some day be flying.

Called "Terrapin" after the University of Maryland's mascot, the two-stage rocket is less than 15 ft long, $6^1/_4$ in. in diam at its thickestpoint, and weighs only 224 lb. It was designed and produced by Republic's Guided Missiles Division in Mineola, L.I., N.Y.

A solid-propellant rocket motor fired the Terrapin to 10,000 ft in six seconds at a speed of 1900 mph. At that altitude, the first stage of the missile separated from the second stage which coasted another 30,000 ft higher. Then the second-stage motor shot the Terrapin to 50,000 ft at a maximum speed of coasted Mach 5.8 or about 3800 mph. The missile coasted the rest of the way to peak altitude. At maximum velocity the rocket experienced temperatures in excess of 1000 F. It was fired from the National Advisory Committee for Aeronautics proving ground at Wallops Island, Va. Throughout the development of the Terrapin, NACA contributed liberally with advice and consultation.

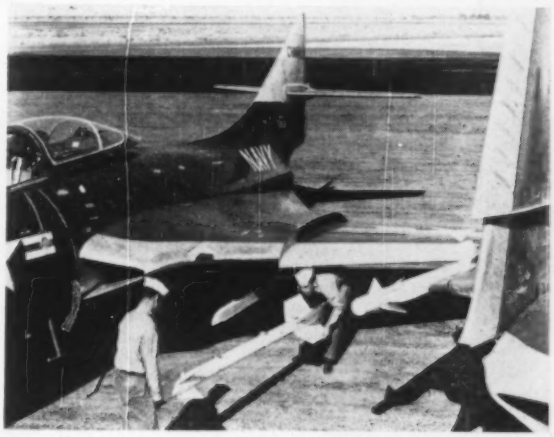
Republic also has completed preliminary design of a third-stage rocket for the Terrapin which would enable it to climb to altitudes of 200 miles and higher in only a few seconds more time.

The research missile, first of several dozen to be produced by Republic, and its collapsible zero-length launcher were especially designed for the upper-atmosphere research program, a Department of Defense project administered by the University of Maryland. It carries special miniaturized instrumentation weighing only 6 lb which was designed at the University.

"Sidewinder" Missile

SIDEWINDER, a lightweight, but extremely deadly air-to-air guided missile is now being produced for the Navy Department, Bureau of Ordnance, by Philco's Government and Industrial Division.

The new missile derives its name, Sidewinder, from a



Sidewinder, air-to-air guided missiles, are small and light enough to be carried by single-seat interceptor planes

term commonly used in the Southwest for particularly vicious rattlesnakes. Small and light enough to be carried in quantity by single-seat interceptor planes, the missile may be fired singly or in salvos. Sidewinder requires no complex launching equipment but is fully maneuverable at supersonic speeds. It has an unusually high single-shot "kill" reliability.

Although details on the missile's guidance system have not been disclosed, the Navy revealed that Sidewinder requires no special pilot training. It may be launched well beyond reach of an enemy aircraft's defense.

Sidewinder is truly a guided missile in that it can change its course to account for tactical movements of an enemy target. Although the time of interception is very short, the missile displayed extreme deadlines during recent field tests. The Navy, which must consider aircraft-carrier space limitations, is especially enthusiastic about the weapon's simplicity, small size, and light weight.

British Atomic Power Station

On October 17, Britain's first atomic power station began production at Calder Hall, Cumberland, in the northwest of England. The first station in the world to produce power from nuclear energy on an industrial scale, Calder Hall was designed also for plutonium production for the military program, by the Atomic Energy Authority. It is one of four identical plants, each one of which, when fully operative, will have an electricity output of over 60,000 kw. The first of the twelve commercial nuclear power plants which will be built by private industry for the electricity authorities by 1965, will be based on this plant's design, but these commercial plants will have an output of 200,000 kw or more.

Britain has reason to push her nuclear program energetically. With limited coal and almost no oil or hydroelectric resources, her energy supplies are short. The outstanding economic need for Britain is that, while rising industrial production will require an increase in energy supplies of perhaps 40 per cent over the next 15 years, coal production can expand by only 11 per cent and even then at an investment cost of well over $3 billion.

Oil will fill part of the gap, but this throws a great strain on the balance of payments. The need to develop nuclear power on a commercial scale in Britain was thus evident, even before the Suez Canal developments raised new problems of oil supply.

Plutonium By-Product

Another economic factor in the commercial power plants based on Calder Hall design is the value of the plutonium which is a by-product of the nuclear reaction. Containing the same amount of heat as three millon times its weight of coal, plutonium is of great potential value in the nuclear power program.

Later stages of the program will see the development of "breeder" reactors, producing more fuel than they consume. An experimental plant of this kind is already being built by the A.E.A. at Dounreay in Scotland.

It is estimated that, while in the early nuclear power

General view of the Calder Hall nuclear power station from the top of one of the filter towers of Windscale, the nearby plutonium factory which houses Britain's first two atomic piles and a chemical plant. From *left* to *right* may be seen reactor No. 2, the turbine house, workshop, and administration building, reactor No. 1, and the two 290-ft-tall cooling towers. Each reactor contains four heat exchangers, one at each corner.

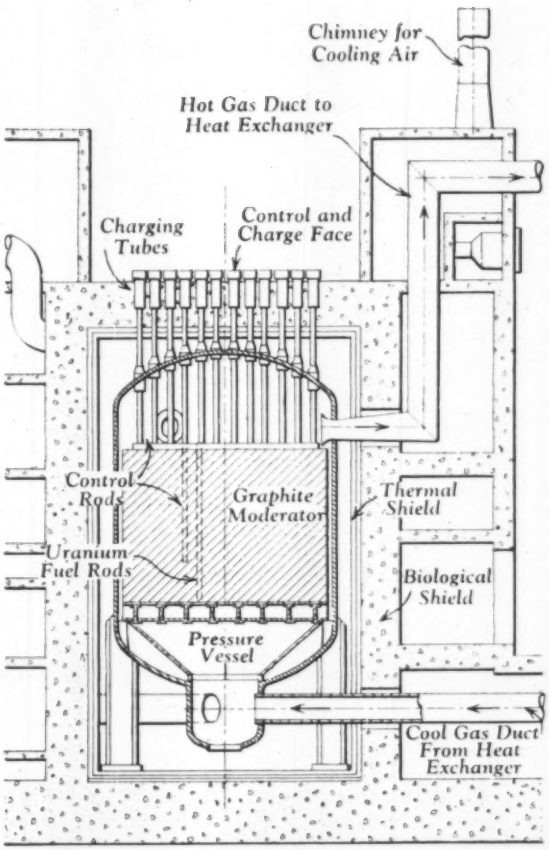


Diagram of a Calder Hall reactor, showing arrangement of graphite moderator and reflector, fuel and control-rod channels, the pressure vessel, and entry and outlet ducts for the coolant gas. The reactor core is housed in a steel pressure vessel. The graphite, containing fuel elements and control rods, rests on flat steel plates. The coolant gas, the temperature of which rises by about 200 C in passing through the core, flows in the annular space between the graphite and the fuel can. (Diagram courtesy *Engineering*.)

stations one ton of uranium will produce energy equivalent to about 10,000 tons of coal, those built in the 1960's should produce ten times as much energy for the same fuel consumption.

The design of Calder Hall, and of the other A.E.A. plants due for immediate erection, is simple and practical. It is of the graphite-moderated, pressurized, gas-cooled type. The reason for this choice of design, rather than the water-moderated reactor favored in the U. S., is chiefly that Britain has to be content with a more modest diffusion plant and so must use natural instead of enriched uranium in the initial stages. This restricted the reactor type to one moderated either by graphite or heavy water. The choice was not difficult, since Britain already had wide experience with graphite reactors and there was no large-scale heavy water production in prospect.

During the second stage of Britain's nuclear power program, enriched fuel will be used in the reactors. This could make use of the plutonium produced by the Calder Hall type stations of Stage 1.

Stage 3 will see the development of much more efficient stations—for example, "fast" or unmoderated reactors, in which a core of pure plutonium will be surrounded by a jacket of uranium-238 or thorium. This is the "breeder" type plant referred to.

Costs of nuclear energy will go down in direct ratio to the increasing efficiency of the plants. And as experience is gained and design streamlined, the capital cost of a nuclear power plant—by far the biggest expense—will decrease.

Safety and Disposal Problem

Finally, there is the safety factor, and this has been so well and carefully solved that already there is talk of erecting future nuclear stations within large cities. It has been pointed out that graphite-moderated, gas-cooled stations of the Calder Hall type are "inherently safe." Six inches of steel plate and a 36-in-thick biological shield surround the reactor's core. A reinforced-concrete roof shield covers the 40 × 60-ft cylindrical pressure vessel housing the reactor shell, the gas connections, and the fuel, control system, and instrumentation entries.

The reactors are so designed that, even if all the controls went wrong and the coolant gases failed to flow, or leaked out, the very beginning of overheating would alter the internal nuclear characteristics of the reactor and shut down the chain reaction.

So far there has been no single fatality nor any detectable injury arising from excessive radiation dosage in Britain's entire nuclear-energy program.

Nor has there been a problem of waste disposal from Calder Hall. All wastes have been disposed of thus far without the slightest danger to humans, animals, or fisheries. There is not expected to be any long-term problem in the storage or disposal of the greatly increased quantities of waste inevitable with expanding operations. There is likely to be progressively less wastage as research develops more by-products from the radioactive by-products.

The time is not far distant when atomic power stations will dot the landscape in Britain. Within five years there will be 26 atomic reactors operating in a country whose land area is a mere 93,000 square miles.

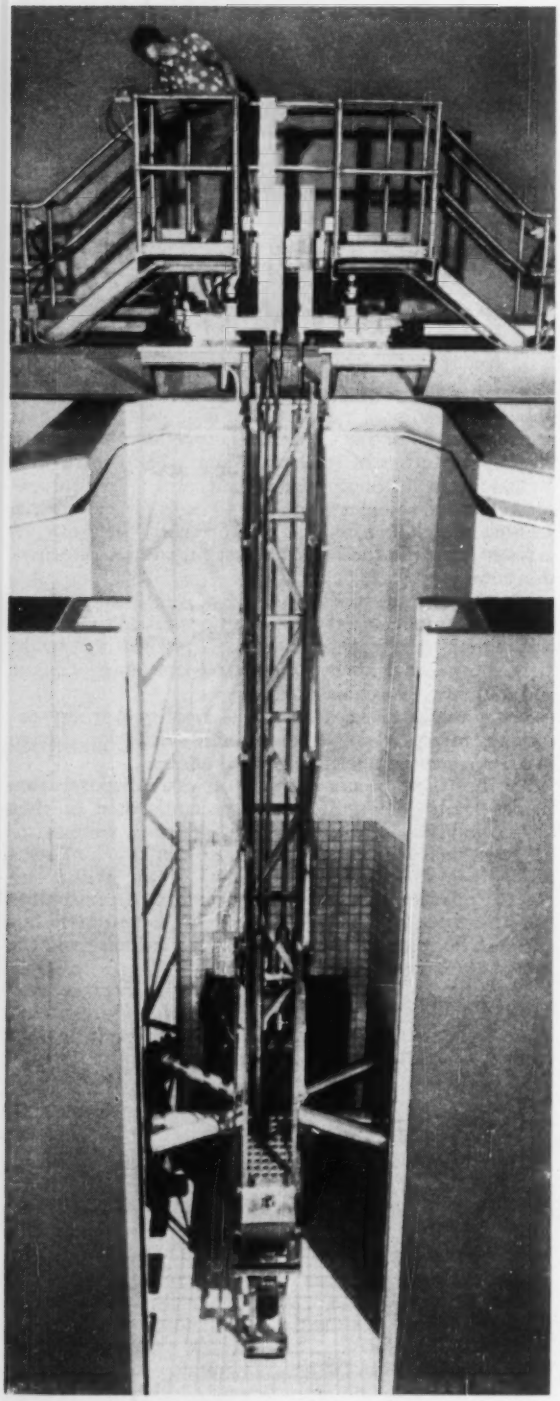
Battelle Research Reactor

THE nation's first privately owned Nuclear Research Center was completed at Battelle Memorial Institute, Columbus, Ohio, according to Dr. Clyde Williams, Mem. ASME, president and director of Battelle. The announcement followed initial "start-up" of the Institute's one-million-watt research reactor.

The ¾ million dollar reactor is the largest of the "pool type" yet to be put in service in this country. It is designed exclusively for research purposes. It becomes the third major new unit added to the Battelle Nuclear Research Center in the past 13 months.

Just over a year ago, radiation laboratories were completed. In February of this year, Battelle announced completion of a laboratory for reactor development.

The newly completed reactor is housed in a three-story building, 72 ft wide × 100 ft long. The two-section, water-filled pool in which the reactor core is sus-



The core of Battelle's reactor is located at the bottom of this suspension tower. When sufficient fuel elements are placed in their proper positions in the plate, nuclear fission begins and the reactor produces gamma rays and neutrons for use in research. Tubes entering from the sides of the pool terminate close to the reactor core face and have specimens inside them when the reactor is operating. Radiation from the reactor penetrates the tube walls and causes changes in the specimens.

pended is approximately 20 ft wide × 40 ft long × 28 ft deep.

The core, composed of fuel elements and boron control rods, takes up a space about 1 × 1.5 × 2 ft at the bottom of a support column which is suspended from the movable control bridge. The core operates at full power in either of two positions. One position is in the approximate center of the pool, where bulk shielding and other large experiments may be performed. The other position is in a stall at one end of the pool, in front of beam tubes and the graphite thermal column. A second movable bridge, with a support column extending downward to the level of the core face, is used for supporting instruments and specimens adjacent to the core.

Cooling, shielding, and controls are all designed for continuous operation at power up to one megawatt.

Two 8-in. and four 6-in-diam beam tubes extending from the outside vertical walls of the pool through to the face of the core are among the locations where specimens or experiments may be placed to utilize neutron or gamma radiation. At the one megawatt level of power, the approximate radiation fluxes are 10^{13} n/cm^2-sec for fast and thermal neutrons and 5×10^{13} photons/cm^2-sec gamma flux.

A second major location for irradiation is the graphite column that provides two 4-ft openings with a thermal neutron flux of 5×10^8 n/cm^2-sec. One of the special features of Battelle's reactor is that access to the thermal column is possible through a horizontal as well as a vertical face.

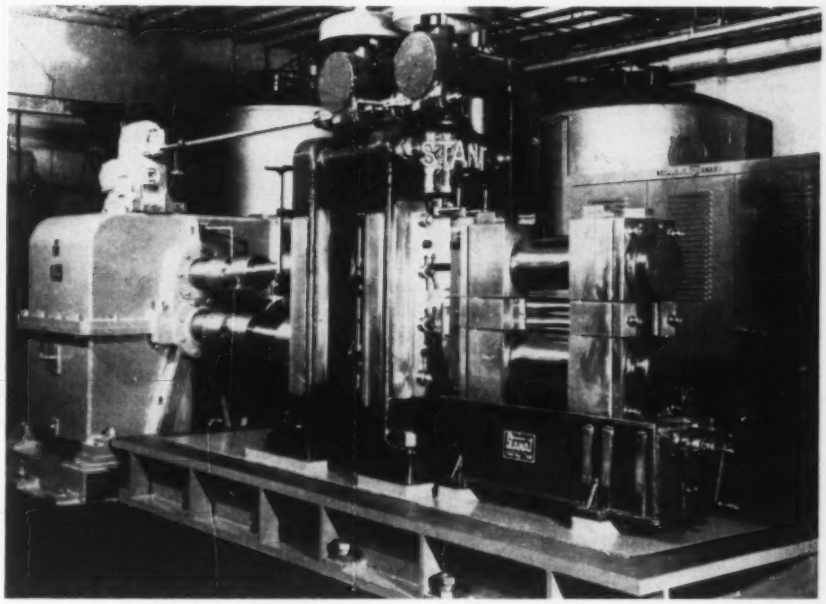
For fast irradiation of relatively small specimens, the reactor is equipped with a special "weasel tube." This will operate hydraulically to carry 2-in-diam specimens to and from the core face with a minimum exposure time of about two seconds. Finally, for large experiments, the core may be moved to the center of a 20 × 20 × 28-ft pool area where bulky apparatus may be brought close to its face.

The reactor fuel elements are composed of a uranium-aluminum alloy clad with 2S aluminum. The uranium in the alloy is enriched to 90 per cent uranium-235. There are ten fuel plates in each element and a total of 35 elements containing, in all, 5.2 kg (about 11.5 lb) of uranium-235. The 28 standard fuel elements contain 162 grams of uranium-235 each, while the two partial elements (used for fine adjustments in fuel loading) contain 81 grams each. The five special elements in which the control rods operate contain about 100 grams each. Depending on core geometry, which is flexible, approximately 2.6 to 3.6 kg (5.7–6.6 lb) of uranium-235 are used to achieve criticality—nuclear fission. At a power level of one megawatt, roughly one gram of U-235 is burned up each day.

The reactor was designed by Battelle physicists and engineered and built by the American Machine and Foundry Company.

Nuclear Rolling Mill

When experiments with nuclear materials required the rolling of fuel elements in a helium atmosphere, Stanat Manufacturing Company of Long Island City, N. Y., was successful bidder for the job of redesigning a two-high and four-high rolling mill for remote-control operation within a sealed plastic envelope.



Rolling mill for nuclear fuel-element processing operates within a sealed plastic envelope (not shown) which follows the outline of the base. Electrical drive and control machinery at left is outside the enclosure and connected through the envelope by shafts.

Working parts are all inside the $^1/_2$-in-thick CR-39 allyl polymer plastic enclosure. All electrical drive and control machinery is outside the envelope. Inside is a helium atmosphere kept at an internal pressure between −0.5 and 1.5 in. of water to create an inflow of air if rupture takes place, thus preventing the scattering of contaminated dust throughout the plant. Radiation from these dust particles is not immediately detectable but apt to lead to cancer ten years later.

The roll-change mechanism for a rapid switch from two-high to four-high operation of the rollers, which soon becomes permanently contaminated, is also automatic. Emergency hand controls permit operation through arm-length gloves incorporated into the envelope, and similar glove operation of adjustments is provided for other parts of the mill.

The Stanat-designed mill penetrates the sealed envelope at only three places, all of them drive-shaft openings. One is for the control mechanism which varies the distance between rollers, the other two are for the drive shafts which turn the large rollers directly and drive the smaller ones by friction. Since the roller operation is variable in width and the whole roller assembly can be changed, these shafts incorporate flexible couplings and terminate in square indentations to which the rollers couple by insertion of square projections. Automatic limit-control switches prevent operation of the machinery if the shafts are in a position that prevents coupling.

The mill is extremely flexible and, although designed primarily for the rolling of plutonium flat-sheet fuel units, can also handle rounds, squares, and ovals for both hot and cold-rolling and can be used with uranium, zirconium, beryllium, and thorium as well as plutonium.

Two units are scheduled for immediate delivery to Argonne, another for the National Reactor Tester Station in Arco, Idaho. The British Atomic Energy Authority has one on order for its own use, another for the Belgian commission, and commercial users are also interested.

Nuclear Briefs . . .

Research Reactor

A RESEARCH reactor with exceptional safety and utility features will be constructed by General Atomic Division of General Dynamics Corporation at the site of its John Jay Hopkins Laboratory for Pure and Applied Science in San Diego, Calif. The Division's plans call for completion of the research reactor by the end of 1957.

It will be a major tool in the laboratory's investigations in the nuclear energy field.

Nuclear Propulsion Plant

The Atomic Energy Commission has accepted as a basis for contract negotiations a proposal by The Babcock and Wilcox Company to design, construct, and test-operate a nuclear propulsion plant for a nuclear-powered merchant ship. The award of a contract will depend on the successful completion of the authorized negotiations. The ship, itself, will be built under contract to the Maritime Administration of the Department of Commerce.

Nongovernment Reactor

Aerojet-General Nucleonics of San Ramon, Calif., announced that, on October 25, the start-up of the first mass-produced training and research reactor, the AGN 201, was accomplished. The reactor went critical with

656 grams of uranium-235 in the form of 20 per cent enriched uranium oxide and, therefore, uses the least able material of any known operating reactor. This new reactor concept is the first to be conceived, designed, constructed, and started-up with private venture capital from a profit-motivated American industrial organization. This first reactor is the prototype on which the immediate mass production of several per month is based.

Gas-Cooled Reactor Experiment

The Atomic Energy Commission has begun contract negotiations with the Aerojet-General Corporation, of Azusa, Calif., for the design, fabrication, and operation of a gas-cooled reactor experiment at the National Reactor Testing Station in Idaho.

The experiment is intended to develop engineering data and experience for the design and construction of military package power reactors and small civilian central-station power plants. The gas-cooled concept is the eighth type chosen by the Commission for research and development work in the program to achieve economic power reactor systems.

Yankee Atomic Power Plant

The contract to develop the nuclear reactor for the Yankee Atomic Electric Company's new atomic electric power generating station has been awarded to Westinghouse Electric Corporation.

The power plant will be built near Rowe, Mass., and will produce 134,000-kw using a pressurized water reactor.

The Atomic Energy Commission will provide assistance in the development and operation of this nuclear station, and up to $5,000,000 has been made available for the development of a nuclear reactor core for the proposed plant. This development work will be carried on in the facilities of both Westinghouse and the Commission.

The $35,000,000 power plant is scheduled for completion and initial operation in 1960.

Nonprofit Nuclear Corporation

Formation of the Carolina-Virginia Nuclear Power Associates, Inc., a nonprofit corporation for the development of atomic power in the area served by its four member companies, has been announced by the Atomic Energy Commission.

The certificate of incorporation was filed in North Carolina by the following companies: Virginia Electric and Power Company, Richmond, Va.; Carolina Power and Light Company, Raleigh, N.C.; Duke Power Company, Charlotte, N.C.; and South Carolina Electric and Gas Company.

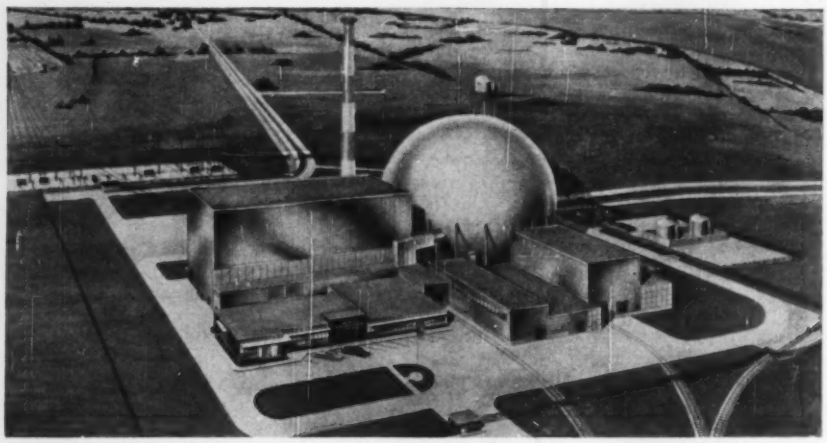
The company will promptly proceed with plans for the construction of a multimillion-dollar nuclear power facility to produce electricity for commercial distribution.

The announcement raises to six the number of atomic power projects initiated by private industry without any direct financial participation by the Government. Five other nuclear power plants for civilian use have been proposed by industry—at a total investment of upward of $200 million—without depending on the Government for financial help.

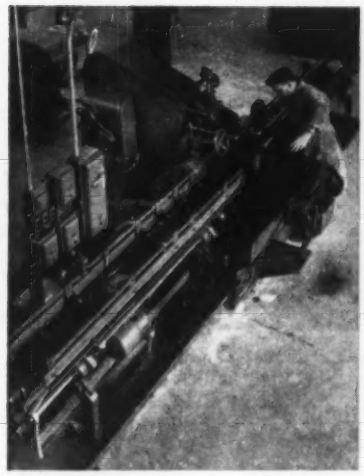
Metal Finishing

A VARIETY of new techniques in the coated abrasive grinding and finishing of metals were demonstrated recently to production men from all phases of the metalworking industry and all parts of the country.

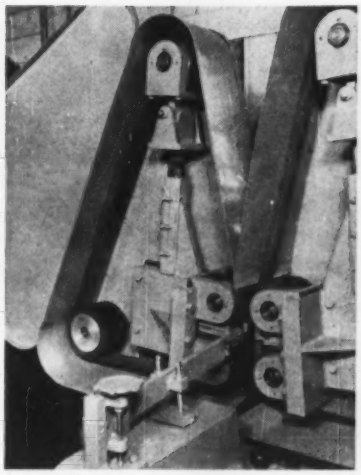
The occasion was the Second National Metalfinishing Show, sponsored by Behr-Manning Company of Troy,



New drawing showing layout of Dresden Nuclear Power Station which General Electric Company is building for Commonwealth Edison Company and the Nuclear Power Group, Inc. The nuclear reactor will be housed in a steel sphere 190 ft in diam. Construction work on the $45,000,000 plant will start next spring with completion set for mid-1960. The 180,000-kw station is the largest all-nuclear power plant yet scheduled in this country and is being financed entirely with private funds. It will be located on the Illinois waterway 50 miles southwest of Chicago and become part of the Commonwealth system which will own and operate the plant.

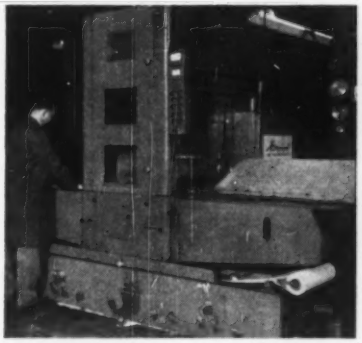


Three-ton centerless grinder, 10 ft in length, handles bar and tube stock up to 4 in. in diam with power-driven fixtures. Coated abrasive belts serve as both grinding and feeding media. Product of Production Machine Company, Greenfield, Mass.

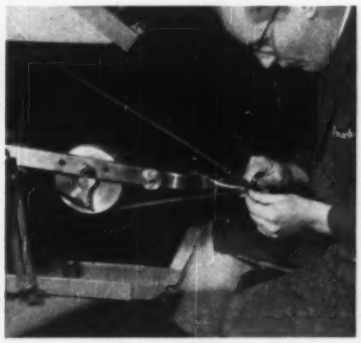


This unusual twin-belt polisher uses opposed abrasive belts and automatic work traverse to finish the two-way taper on silver flatware, finishing both sides simultaneously, and working wet or dry. Product of Nicholas Equipment Company, Bellevue, Ohio.

Air-powered vertical sander is spinning a coated abrasive disk at 6000 rpm to put a smooth finish on the narrow flange of a refrigerator part. A sponge rubber pad gives the disk the correct degree of flexible support. Product of Buckeye Tools Corporation, Dayton, Ohio.



The flat finisher was designed for wet abrasive belt grinding, polishing, and deburring of flat stock such as sheets, strips, bars, stampings, and plates up to 12 in. wide and 6 in. high. A variable-speed conveyer belt feeds work at rates up to 44 fpm. Product of Hammond Machinery Builders, Inc.



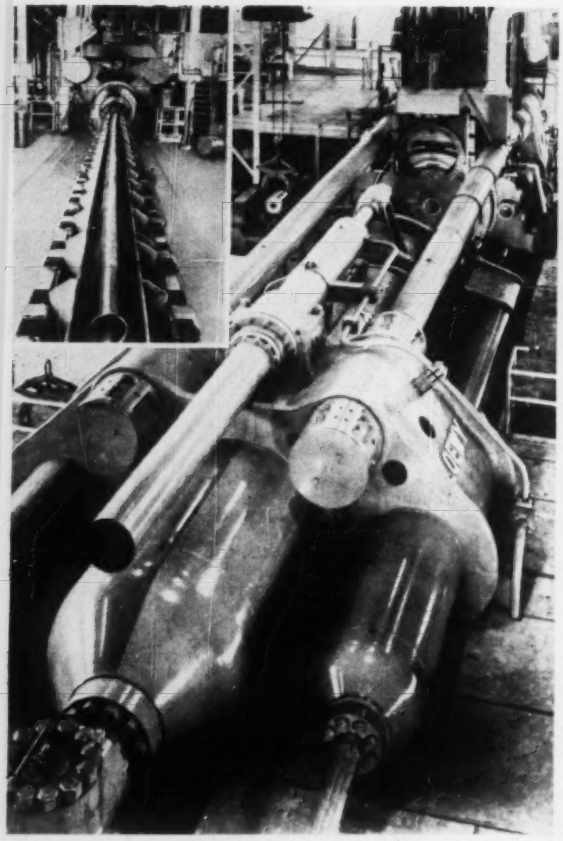
The exacting work of polishing turbine blades for jet engines is performed on a new jet-blade polishing head which replaces the standard yoke on a Bader Space Saver. The $^{3}/_{4} \times 132$-in. coated abrasive belt travels at 2800 sfpm. Product of Stephen Bader & Company, Valley Falls, N. Y.

For deburring, as shown, light grinding, polishing, or cleanup work, a portable abrasive belt unit becomes a versatile production tool. Grinding may be done on the contact wheel, on the platen, or on the free-belt area between wheels. Product of Grinding and Polishing Machinery Corporation, Indianapolis, Ind.

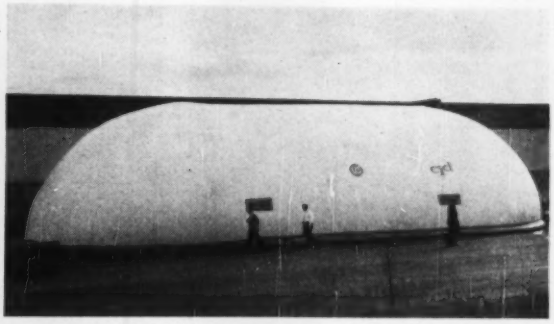
N. Y., a division of Norton Company, at the abrasives manufacturer's clinic rooms, October 29-November 2 in Cleveland, Ohio. Purpose of the exhibit was to provide a clearing house of information and education on the many new developments in a technology which is expanding rapidly. The exhibit consisted of nearly 100 machine tools and metalworking machines, most of them developed within the past two years and many shown for the first time. They were the products of 34 manufacturers who were guests of Behr-Manning. Throughout the week, industrial production men brought actual workpieces for comparative testing on new equipment which ranged from huge automatic machines destined for automobile and appliance production lines, to small specialty tools for such exacting work as removing defects from the contoured surfaces of jet engine blades.

Specialty machines developed for grinding and finishing aircraft and engine components accounted for the presence of representatives from several West Coast plants. One of the largest automobile companies assigned its abrasives technicians to a two-day stay at the show, and a Rochester, N.Y., distributor underwrote the trip for customers who filled two railroad cars.

Features of the show included lecture demonstrations by Behr-Manning scientists and engineers, and the showing of a new color film on the uses of abrasive disks in metalworking.

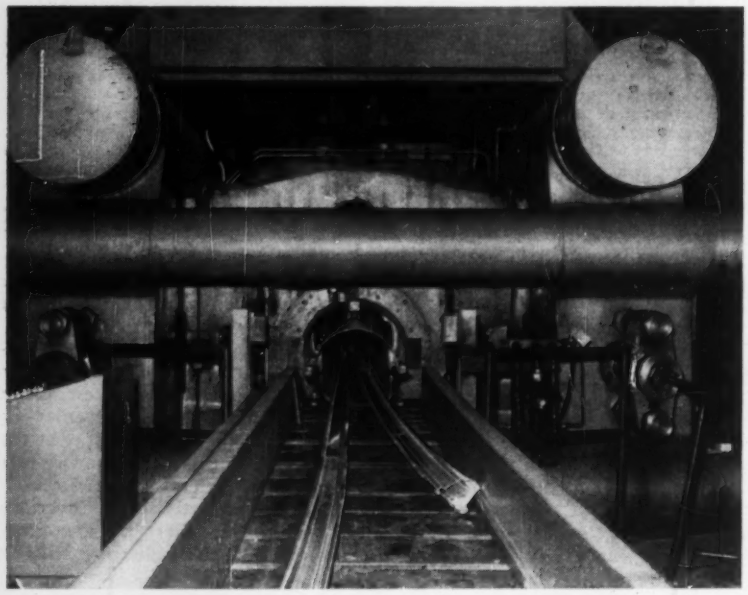


12,000-Ton Extrusion Press. The only press in the U. S. Air Force Heavy Press Program for the extrusion of steels and large titanium components is now in full operation. Operated by the Metals Processing Division of Curtiss-Wright in Buffalo, N. Y., the 126-ft-long horizontal extrusion press has a squeezing power of 12,000 tons. It was designed, built, and installed by Loewy-Hydropress Division of Baldwin-Lima-Hamilton. The Heavy Press Program enables the aircraft industry to construct stronger, faster, and higher flying planes.



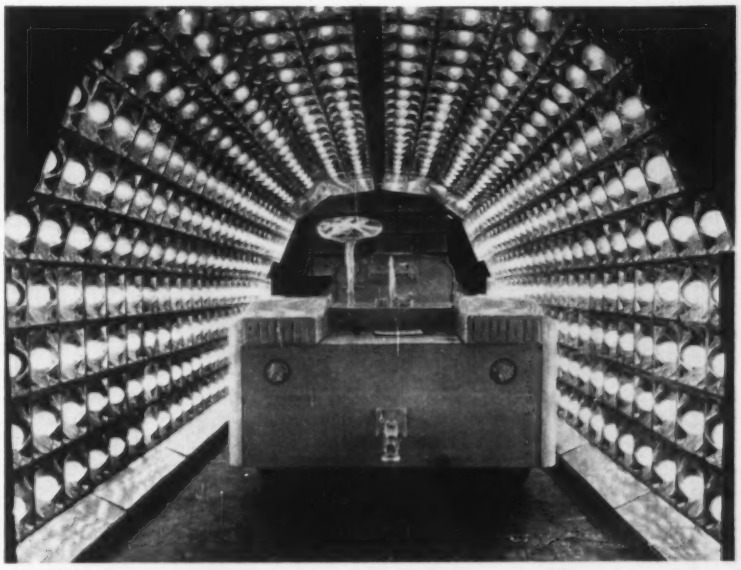
Portable Warehouse. Pneumatically supported at low pressure and large enough to hold two million pounds of packaged goods, this portable warehouse was developed by United States Rubber Company for Calumet Industrial District, Chicago, Ill. It contains 64,000 cu ft of storage space, weighs 400 pounds, and costs about $2000. It is made of a paper-thin, lightweight, extremely tough nylon fabric called fiberthin, coated with vinyl plastic.

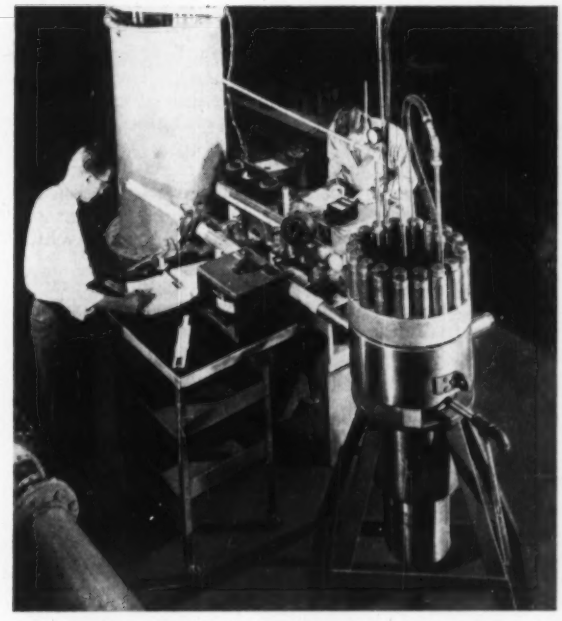
Photo Briefs



8100-Ton Extrusion Press. The West Coast's first big Air Force press to go into operation is now in full production. The 126-ft hydraulic extrusion press can exert pressures up to 8100 tons and is capable of squeezing out complex shapes of unprecedented length. Designed, built, and installed by Loewy-Hydropress Division of Baldwin-Lima-Hamilton, the press is now in operation at the Harvey Aluminum plant in Torrance, Calif. The press proper is operated by one man, who directs all motions from his "pulpit." For the first time, a mechanized runout table is used, with an operator riding a Loewy-designed "puller-gripper." This puller-gripper offers maximum control in the handling of multiple and other types of extrusions. The new installation, which is part of the Heavy Press Program, is producing vital structural members for the B-52 and other advanced aircraft and missiles.

Infrared Oven. Ten minutes after being sprayed, Allis-Chalmers lift trucks and tractors are ready for delivery, thoroughly dried by infrared heat in a new automatic radiant oven. Air drying the painted trucks formerly took from 8 to 48 hr at the company's Harvey, Ill., plant, often causing a slow-down in the finishing department. Their new radiant oven, manufactured by Fostoria Pressed Steel Corporation, Fostoria, Ohio, is just 18 ft 4 in. long, equipped with G-30 lamps having a total connected load of 100 kw. Faster, more uniform drying in the infrared oven has improved production, quality, and finish. More accurate control of intensive heat, provided by infrared energy directed evenly over entire painted surface, is one of the factors in obtaining such swift drying results.





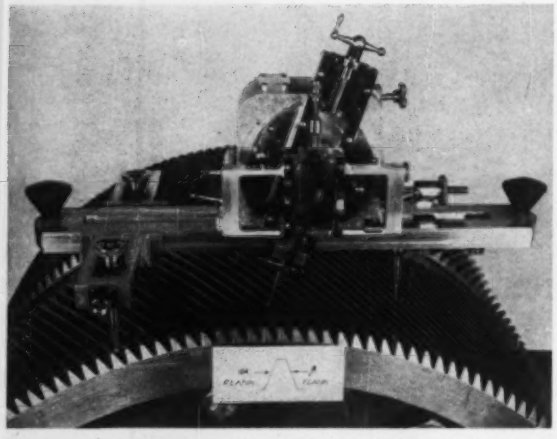
Leakproof Centrifugal Blower. This development for handling corrosive, toxic, and radioactive gases at high temperatures and system pressure has been announced by Allis-Chalmers Manufacturing Company, Milwaukee, Wis. The blower will handle 20 cfm of gas having a specific gravity of 6 and will develop a 150-ft head in a 2000-psi system. It is designed to operate at gas temperatures up to 500 F. The unit consists of a centrifugal blower and canned motor sealed in a heavy stainless-steel enclosure. Fluid piston radial and thrust bearings make the leakproof design possible. Radioactive contamination and corrosiveness of the water in the rotor and bearing cavity are limited by labyrinth seals at the water-gas interface.

Circular Cutters. These circular cutters for machining aluminum honeycomb parts for the USAF Northrop SM-62 Snark intercontinental missile, are used at Northrop Aircraft, Inc., Hawthorne, Calif. The cutters vary in size from 6 to $^3/_4$ in. in diam. Deviations from the circular-type cutter are shown on the work bench at lower left. The cutter at *left* has three V-shaped serrations, and on the *right* a cutter with two chip breakers is shown. These are used for extremely deep cuts. Cutters vary in size to achieve an ideal speed of cut without burning the material. Ground with a one to two-degree bottom concave clearance angle, they vary in top clearance from 10 to 30 deg. Speed of cut varies from 10,250 rpm to 35,000 rpm.

European Survey

Engineering Progress in the British Isles and Western Europe

J. Foster Petree,[1] Mem. ASME, *European Correspondent*



Gear-tooth profile gage for large marine gears, designed and made by M.E.R.L.

U. K. Mechanical-Engineering Research

For nearly half a century the chief center for mechanical-engineering research in Great Britain was the National Physical Laboratory, but experience during the second World War showed that this establishment was hardly adequate to the needs of the nation and the industry. In 1947, therefore, a new Mechanical Engineering Research Laboratory was set up at East Kilbride, on the outskirts of Glasgow, Scotland, to take over the work of the Engineering Division of the National Physical Laboratory. The transfer is not yet completed; the research on lubrication and wear, for instance, was transferred to East Kilbride in 1949, but the task of transferring that of the metrology division is still in progress. It is expected to be brought much nearer to completion by the end of the present year, as the new air-conditioned building for this division is now practically ready for use; in due course it will accommodate the master lead-screw correcting machine and a master gear-generating machine for correcting master worm wheels and gears up to 48-in. diam.

It has long been the practice at the N.P.L. and at others of the Government-sponsored research establishments to hold annually one or more "open days," on which representatives of the industries served may see for themselves something of the work that is being done. Because of its incomplete state, the Laboratory at East Kilbride did not do so during the first eight years of its existence, but a few weeks ago it opened its doors to the engineering profession and industry; and it is the intention to continue this practice.

[1] Correspondence with Mr. Petree should be addressed to 36 Mayfield Road, Sutton, Surrey, England.

The Laboratory occupies a site of about 70 acres at East Kilbride, and also has some temporary quarters at Thorntonhall, about four miles away from the main establishment. Its work is organized in seven Divisions, lettered A to G, and dealing respectively with Materials, Fluids, Lubrication, Metrology, Plasticity, and Heat. The staff at July, 1956, numbered 407, of whom more than half have had scientific or technical qualifications. The program of research to be undertaken is under the guidance of a mechanical-engineering research board consisting of scientists and engineers representing the industry and the universities, who are selected for their special knowledge and experience. Their appointment is under the authority of the Department of Scientific and Industrial Research, a Government department which was formed in 1916 to organize the application of scientific research to trade and industry generally.

Division A (Properties and Strength of Materials) is combined at present with Division B (Mechanics of Solids, Stress Analysis, and Vibration). Their work is mainly the investigation of the strength of materials in the presence of stress raisers such as oil holes or keyways (particularly under repeated loading), research on fatigue at high temperatures, the creep behavior of structural elements (especially problems arising from the high temperatures developed in flight at supersonic speeds), and the examination of components which have failed in service.

Division C (Mechanics of Fluids, including Hydraulic Machinery) is notably well equipped, and it is claimed that the hydraulic machinery building is the largest and most advanced laboratory of its kind in the world. It has been designed for fundamental and applied research on all mechanical-engineering flow problems involving water, air, or other fluids, especially those concerned with water turbines and pumps, fans, valves, and oil-pressure mechanisms. There are open circuits for performance tests at rates of flow up to 12,000 gpm, a closed circuit for cavitation research on centrifugal and mixed-flow pumps taking up to 350 hp, and another for similar research on water turbines which will enable models to 250 hp to be tested at heads up to 200 ft. A special laboratory has been provided in which hydraulic plant can be tested by using air as the working fluid.

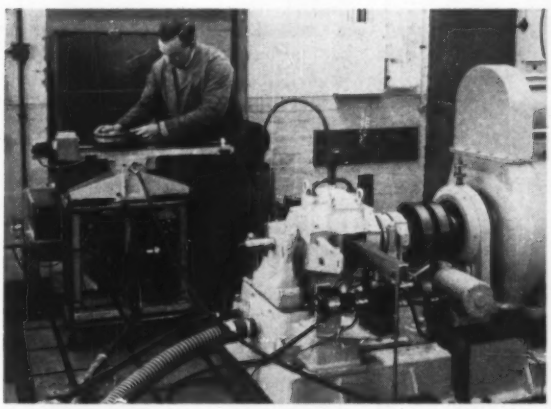
Division D (Lubrication, Wear, and Mechanical Engineering Aspects of Corrosion) covers a wide and varied field and has been responsible for the development of some interesting techniques. The scientists of this Division have introduced refinements which have greatly extended the utility of the hydrodynamic lubrication of journal bearings by means of glass bushes. The glass bushes are now made with very great accuracy, and ultraviolet light makes the oil film visible by fluorescence. With an electronic flash, the film formation can be photographed under conditions of steady

or dynamic loading to show the form and position of the cavitation in the unloaded part, and to show also the influence of oil entry conditions on the extent of the film. Another line of research which is being followed by this Division is the use of radioactive tracers in the study of boundary lubrication; for example, to measure the amount of metal transferred when two metal surfaces are in frictional contact. If one surface is radioactive, the transfer of particles to the other can be determined by measuring the radioactivity of the previously inactive surface; by this means it is possible to measure quantities as small as 10^{-10} gm.

Division E is concerned with Mechanisms, Engineering Metrology, and Noise Control, these three fields of inquiry being linked together by the fact that performance and noise depend largely on the dimensional accuracy of the components. An important part of the work of the Division is the investigation and certification, for industrial firms and for other Government Departments, of the accuracy of parts, surfaces, and even complete machines. Precision dynamometers are being developed for research on transmissions ranging from $^1/_4$ hp to 350 hp, and these will be available also for the accurate measurement of power losses in commercial units. Measurement of the accuracy of gears is another branch of metrology to which particular attention is being directed, and in which various new measuring instruments have been devised. One of these is a rack-type production inspection machine, which enables cumulative and adjacent pitch errors as well as profile errors to be evaluated quantitatively. The instrument can be used also for dual-flank mesh tests. Another new instrument is a tooth-profile recorder for use on large marine gears which gives, on a plate of smoked glass, a trace which is magnified ten times, so that, in conjunction with an optical projector, it is possible to study the tooth profile at a magnification of 500; that is, an error of 0.0001 in. is observed as 0.05 in.

A development which has greatly minimized one of the most tedious inspection tasks is that of an automatic indexing machine for measuring gear-tooth pitch errors.

Metal forming and cutting processes are the concern of Division F (Mechanics of Formation and Machine Shaping of Materials). The study of extrusion is one of the principal activities at the present time.



75-hp precision dynamometer investigating losses in power transmission units

Division G (Heat Transfer, Heat Exchange Apparatus, and Applied Thermodynamics) will greatly extend its researches in the near future, as a large new block for the study of heat transfer is due to be completed in 1957. Recent developments such as nuclear energy power stations and high-speed flight have introduced conditions of heat transfer for which no design data are available. It will be one of the main functions of Division G to meet this need. Work is proceeding on the preparation of consistent tables of the main thermodynamic properties of technically important gases in a form suitable for industrial use.

England-France Electric Power Link

In the October, 1956, "European Survey," page 950, it was mentioned that a project was under consideration for laying an electric power cable across the Straits of Dover (the French call it the Pas de Calais) to link up the system of the Central Electricity Authority in England with the network of Electricité de France. A few days after that was written it was announced that agreement had been reached by the joint committee which had been working on the scheme and that they had recommended that the connection should consist of a single cable to transmit direct current, with a capacity of 120,000 to 150,000 kw at 200,000 volts. It is hoped to start work early in 1957 and the installation, which is estimated to cost about $11,000,000, will be completed in 1960. The minimum width of the crossing is about 21 miles. The idea originated in the latter part of World War II but it was then judged, on technical grounds, to be uneconomical. It was revived in 1951, by which time considerable advances had been made in the manufacture of high-voltage cables, and a program of tests was undertaken on the basis of using single-core gas-filled preimpregnated paper-insulated cables to transmit, by three-phase alternating current, 150,000 kw at 132,000 volts. This would have required four cables, one being in reserve. The test results were satisfactory, but this scheme was dropped about a year ago in favor of d-c transmission, following the success of the 100,000-volt interconnection between Sweden and the island of Gotland and the progress made in developing high-power mercury-vapor mutators. A fresh study was begun, therefore, to provide a comparison between a-c and d-c transmission in the light of this new knowledge and it was found that, with d-c, a single cable would suffice. Other significant advantages of the d-c proposal are that it will allow the two interconnected systems to control their respective frequencies independently of each other and to regulate the agreed interchange of load with greater precision than would be possible with alternating current. It will be interesting in due course to see whether this power link will affect the trade in seaborne coal between England and France. This traffic flows in both directions, for, while France imports a considerable tonnage of anthracite and of briquettes (made of coal dust held together by a pitch or other binder) from South Wales, at the present time some of the power stations on the South Coast of England are operating on French coal. It is not unknown, in fact, for a ship that has taken Welsh coal to France to load French coal for the return trip to England, the economic justification being, of course, that the coals are of different types, and that the haul from France is shorter than from the English coal fields.

ASME Technical Digest

Substance in Brief of Papers Presented at ASME Meetings

Gas Turbine Power

5000-Kw Dual-Fuel Gas Turbine for Industrial Power, by R. J. Brown, Assoc. Mem. ASME, and A. N. Smith, Mem. ASME, General Electric Company, Schenectady, N. Y. 1956 ASME Fall Meeting paper No. **56—F-20** (multilithographed; available to July 1, 1957).

A 5000-kw, dual-fuel, simple-cycle, single-shaft gas turbine-generator plant is described in this paper, and its features are discussed and expected performance is given.

The axial-flow compressor has 15 stages. The turbine has two stages. The six combustion chambers operate up to 1450 F discharge temperature. The control means for starting and stopping the plant and for controlling the turbine speed, temperature, and fuel during operation are discussed. The lube system is similar to steam turbines. The plant is started with a steam turbine.

The gas turbine and accessories are mounted on a steel base. The reduction gear, generator, and exciter are mounted on a matching base. The outline dimensions and weights are given for installation information.

The controls and fuel systems are arranged to start and to operate the unit on either gas or distillate oil. Fuel transfer from one to the other can be made during normal operation. These systems permit simultaneous operation on both fuels.

Management

Engineering Management in Reclamation, by L. N. McClellan, Bureau of Reclamation, Denver Federal Center, Denver, Colo. 1956 ASME Fall Meeting paper No. **56—F-17** (multilithographed; available to July 1, 1957).

Sound management is just as vital to the effective operation of modern government as it is to modern business. While our government faces many of the basic problems that confront private industry and employs many of the same management tools, sometimes the tools need to be sharper to do the job. This paper presents some of the problems of a part of one agency of the federal government, the Denver offices of the Bureau of Reclamation.

The work of the Bureau of Reclamation is to build irrigation and hydroelectric projects in the 17 western states under authorization of Congress.

The Denver offices are the central technical headquarters of the Bureau. They are responsible for the review of project plans, for engineering design, specifications, contract management and supervision of construction.

Reclamation, unlike private industry, does not have to show a profit—and it does not have to report to a board of directors. However, they must answer to the executive branch of the government and to Congress. They are also responsible to the ultimate beneficiaries of reclamation—the irrigators and power users—who must repay construction costs.

There are few enterprises subject to more intensive scrutiny and evaluation.

Good management recognizes its obligation to inform adequately its directors and customers. In government, many of these reporting requirements are imposed upon the individual agency, and the task is to fulfill them as efficiently as possible. The larger and more complex the organization, the more voluminous and intricate becomes the reporting chore.

This paper discusses in detail the solutions to some of the problems of management of the Denver offices of the Bureau of Reclamation.

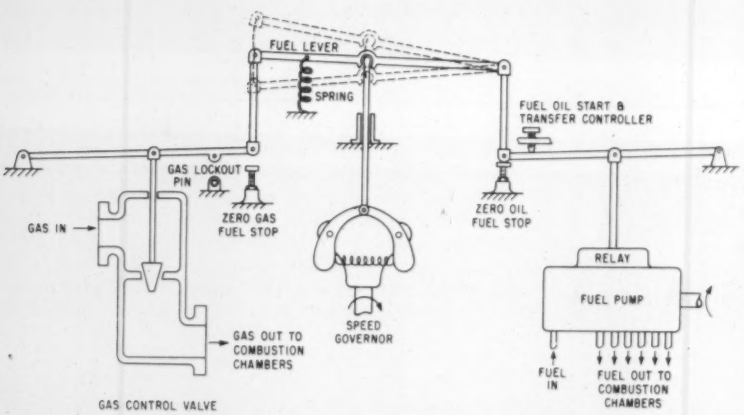
Process Industries

A Preliminary Analysis of a Turning Jet, by A. S. Leonard, Department of Agricultural Engineering, University of California, Davis, California. 1956 ASME Fall Meeting paper No. **56—F-19** (multilithographed; available to July 1, 1957).

Although such familiar examples of a turning jet as a desk fan and the rotary lawn sprinkler have been with us for many years, very little work appears to have been done toward making reasonably accurate analyses of their action, as the state of affairs of the market for these items did not urgently call for industrial research.

In recent years the wind machine has been brought into rather widespread use for frost protection, particularly in the citrus orchards of Southern California. The most common design of wind machine has one or two thrust units (facing in opposite directions when two are used) mounted at the top of a tower 30 to 35 ft from the ground. The strong mixing action of the jet produced by the propeller mixes the cold air of this layer with the warmer air overlying it, and thus raises the temperature of the air in contact with the trees.

Because the cost of a single wind machine may be as high as several thousand dollars and because the crop and trees that it is intended to protect usually have a much greater value, the orchard grower is very much concerned with the degree



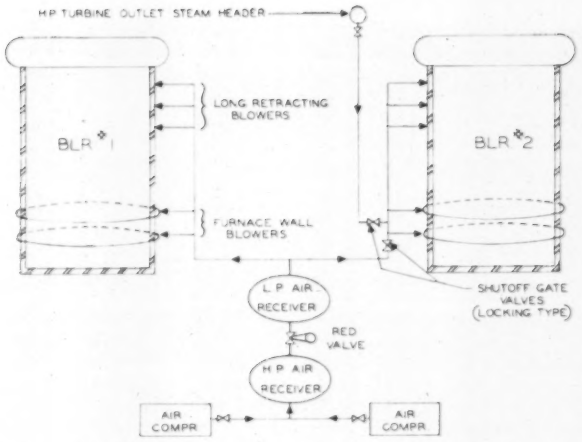
Schematic diagram of the 5000-kw dual-fuel control concept for the gas turbine

of frost protection that the machine can provide, and the area covered.

This state of affairs is much more conducive to research, and is what prompted the study which is reported in this paper.

From the relatively limited experiments which had been performed up to this point, one fact became clear—close in, the flow pattern is approximately that of a stationary jet; but somewhere along the line the stream runs into the proverbial "brick wall," and from there on, decelerates at a surprisingly great rate. It behaves almost as if the fluid were being conducted out radially through a tube, formed by the inner part of the jet, to some fixed distance and then deposited there almost at rest with respect to the surrounding fluid. Thus, since the cross section of the jet is nearly circular, the outer part of the turning jet (lag angle greater than about 30 deg) has approximately the shape of a toroid. Since the fluid of the outer part of the jet continues to move away from the point of turning, though slowly, it should be thought of as a slowly expanding toroid.

Assuming this concept of the outer part of the turning jet to be approximately correct, it was felt that a solution to the problem could be obtained by combining the laws of the stationary jet and those of the expanding toroid in a single set of equations. These equations would have to be of such form that for small radial distances they would reduce to the equations of the stationary jet, while for large distances they would approach those of the expanding toroid.



Schematic arrangement of air blowing with emergency crossover steam supply

Power

Boiler Cleaning—Methods and Controls, by L. B. Schueler, Mem. ASME, Diamond Power Specialty Corporation, Lancaster, Ohio. 1956 ASME Fall Meeting paper No. 56—F-13 (multilithographed; available to July 1, 1957).

In recent years, there has been a great increase in the complexity of boiler cleaning requirements and problems. From a relatively few blower units which could be operated on a standard program of sequence and at regular time intervals, we now often face a great number of blowers and a variety of functional cleaning requirements.

The selection of a blowing medium, namely, steam or air, has received much attention ever since the first use of air for blowing on a large scale late in the 1930's. Also it has been established that refinement in nozzle design and attention to detail results in greatly improved performance and efficiency.

In making an analytical study of steam versus air blowing, there are a number of major and minor factors which influence the final answer. This paper contains a discussion of these factors.

With the increasing use of higher steam pressures, over 1200 psi, there has been a decided preference for superheated steam rather than for saturated steam for blowing. There is also considerable interest and some trend toward the use of crossover steam (high-pressure, turbine-exhaust steam on reheat units) for blowing. This source, at about 450 psi, 725 F at full load, is ideal for cleaning all types of surfaces with most fuels.

The use of stellited seating surfaces for integral blower valves is rapidly becoming common practice. This gives greater assurance of tight valves and lower maintenance costs.

Also outlined in this paper are the developments in air blowing since the early 1930's.

With the rapid growth in size and number of boilers in any central station plant has come a corresponding rapid trend to low-pressure (250 to 350 psi) air systems. It would be well, the author points out, for designers to consider the advantages of low-pressure systems for the first unit in a given plant even though the economics did not warrant such selection until the second or third units are involved.

One factor of considerable significance in evaluating air-blowing systems is that of a spare compressor. With large compressor units running from $60 per cfm, installed, and up, it can be seen readily that even one spare compressor can involve an outlay of many thousands of dollars. It is suggested that consideration might well be given to an alternative, that is, to supply crossover steam to a number of blowers on a boiler equivalent to the output of one compressor and used in lieu of a spare compressor when one of the main compressors is unavailable.

The author believes that there may be a rather rapid trend toward centrifugal compressors once the design and operating conditions can be reconciled properly.

An analytical comparison of air and electric-blower systems is divided into two basic considerations, namely, drive and control. The author discusses the advantages and disadvantages of the air and electric blower systems at length from these viewpoints.

As boiler units become larger and more complex, blower systems logically can be considered as groups of blowers which have specific functions in maintaining these basic operating conditions. Thus, we see that automatic blower-control systems should more logically consider the selection of these functional groups of blowers rather than the many individual blower units.

As we proceed and progress in the development of blower-system control for large central-station units, we can visualize the approaching need for a complete automatic concept of control, without operator action. Such a control concept need not be overly complex and will lead to the most effective and efficient form of over-all cleaning—by functional need rather than by traditional habit and practice.

Power From Solar Energy—Some Fundamental Factors, by J. I. Yellott, Mem. ASME, Association for Applied Solar Energy, Phoenix, Arizona. 1956 ASME Fall Meeting paper No. 56—F-15 (multilithographed; to be published in Trans. ASME; available to July 1, 1957).

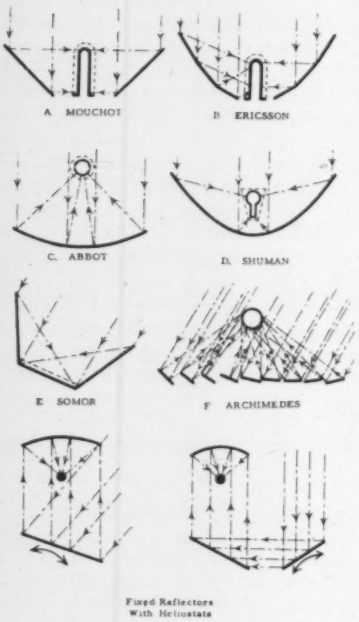
FOLLOWING a brief historical introduction, the paper points out the need for solar energy to supplement fossil fuels and nuclear power.

Generation of useful amounts of power from solar energy is a goal which has been sought by engineers for at least a century. Thus far, the goal has not been attained in so far as power is concerned, although heating of water is readily and economically accomplished.

The nature of solar radiation is described, and methods are given for estimating the amount available at any particular location. This paper has been prepared with the intention of setting forth some of the principal factors which control the design of solar-power equipment. It will be realized that thermal efficiency of solar apparatus is important because of its effect on the size and hence the first cost of the heat collectors and rejectors, rather than on the more usual aspect of fuel-cost reduction. Flat plate and concentrating collectors are discussed, and recent technical advances are reported, including selective surface coatings and new tube-in-sheet materials.

This combination of selective surfaces, tube-in-sheet materials, and ingenious arrangement of concentrator elements gives promise of raising both the temperature and the efficiency at which collection systems will operate. If the engineer can develop small prime movers of good efficiency, the over-all result will be the building of small solar plants at reasonable cost. Cycles and prime movers are given detailed consideration in this paper.

The use of such plants for irrigation, refrigeration, and generation of small amounts of power for village lighting, communication, and light industry can have an important effect upon the standard of living in many parts of the world.



Shown here are many of the important combinations of mirrors and lenses developed during the history of man's effort to gain useful amounts of power from solar energy.

Instruments and Control—Key to Economical Performance of Steam Power Plants, by P. S. Dickey, Mem. ASME, Bailey Meter Company, Cleveland, Ohio. 1956 ASME Fall Meeting paper No. 56—F-14 (multilithographed; available to July 1, 1957).

FIVE stages in the development of instruments and automatic control for the steam-electric power plant are outlined in this paper. Increased use of instrumentation is necessary for safe and efficient operation of modern high-capacity, high-pressure, and high-temperature steam-electric generating units. Whereas automatic control was first used primarily to avoid damage to major equipment, it has become essential today for reasons of economy as well as safety and reliability. Present concepts of instruments for a large unit require separation of apparatus used as operating guides to maintain continuity and safety, from those devices used for precise performance - efficiency determination. Automatic data-gathering and data-processing equipment will be useful for the latter function.

Estimating Partial-Load Performance of Large Reheat Turbine Generator Units, by S. D. Fulton, Mem. ASME, and D. W. R. Morgan, Jr., Mem. ASME, Steam Division, Westinghouse Electric Corporation, Lester, Pa. 1956 ASME Fall Meeting paper No. 56—F-16 (multilithographed; to be published in Trans. ASME; available to July 1, 1957).

THE electric utility industry today is faced with the problem of selecting the most economical generating unit from an increasing number of available types and steam conditions. Study of long-term and seasonal operating conditions further complicates the problem, and necessitates preparation of considerable full and partial-load performance data on alternative propositions which merit consideration. To conserve time and manpower without sacrificing adequate study of reasonable alternatives, means must be provided for facilitating the selection through the use of estimating procedures which give truly comparable data.

As a step in the direction of making information more readily available, the authors have developed a short method of determining partial-load reheat-cycle heat rates with an accuracy well within that required to make a selection between two or more specific units. The only data required are the heat rate at capability, the turbine type, last blade row annulus area, the mean diameter velocity of the last blade row, and the steam conditions.

While the information is based on turbines as manufactured by the authors' company, it is believed that it will be applicable to similar turbine types of other manufacture.

Production Engineering

Measurement and Mechanization of Production Control Scheduling, by H. Ford Dickie, Production Control Service, General Electric Company, New York, N. Y. 1956 ASME Fall Meeting paper No. 56—F-2 (multilithographed; available to July 1, 1957).

THIS paper pictures the manufacturing system of the future. An automatic system in which the typing of the customer's order would be the first and last manual operation is seen as a key to reduced operating costs.

The author suggests that the "paper curtain" separating manufacturing, finance, marketing, and engineering may be torn down as plants become more automatic. This destruction of barriers between departments may well bring new benefits in the form of functional integration.

An electronic system is described that would automatically transmit information to the manufacturing plant, the district office, the warehouse, and the customer, starting at the time a customer's order is received. At the factory, other machines would maintain inventory information and schedule various manufacturing steps through a complicated system that would take into account dozens of variables and instantaneously adjust itself whenever an unexpected event, such as a breakdown, occurred on the production line.

Machines to perform these complex

functions are now available or will be on the market within a year.

At the same time that machines become more complex, systems and procedures should be simplified. Progress depends to a considerable extent on seeing to it that the simplification processes move forward in approximate balance with the complicating processes so that individuals do not become casualties of their own complexities.

In time, progress in the mechanization of manufacturing control will fully match automation advancements in the shop. Production control systems, the author points out, have been stagnant for 20 years. The advent of operations research techniques, the greater interest of industrial engineers in production management, and the increasing availability and understanding of electronic computers promise a brighter future for office automation.

The author contrasts today's conventional systems, under which an office staff handles great masses of paper work and goes through a process of trial and error to arrive at an efficient work load, to production machines, a new scheduling computer. This desk-size machine, which stores thousands of pieces of information in its electronic "memory," enables a scheduler to determine the load on his production line simply by setting a dial for the quantity of products desired. The machine automatically extends, summarizes, and instantaneously compares this potential load with the available production capacity.

Such systems cut manufacturing costs by reducing idle machine time.

Other aspects of a completely automated plant are outlines, including a single center combining engineering and factory operational planning, production scheduling, and marketing-data planning. No more blueprints would be sent into the shop. Instead, magnetic tapes would guide the machines in time, quantity, and dimensions.

Hydraulics

Cavitation Characteristics of Gate Valves and Globe Valves Used as Flow Regulators Under Heads Up to About 125 Ft, by J. W. Ball, Engineering Laboratories, Bureau of Reclamation, Denver, Colo. 1956 ASME Fall Meeting paper No. 56—F-10 (multilithographed; to be published in Trans. ASME; available to July 1, 1957).

THE series of tests discussed in this paper was made for the purpose of determining whether or not gate valves or globe valves could be used satisfactorily for regulating releases from irrigation-distribution systems under heads up to about 125 ft. Both types of valves proved unsuitable for making free-flow releases because of the wide dispersion of the jets under throttled conditions. Confinement of the jets to pipelines downstream induced cavitation in and downstream of the valves, and a study was made of the pressures in the pipelines upstream and downstream of 6, 8, 10, and 12-in. gate valves, and a 6-in. globe valve to evolve a means of eliminating or minimizing the cavitation. A pressure relationship or "cavitation index" was found to be a useful means of determining the limits of differential head and back pressure to either control the location of, minimize, or eliminate cavitation damage. The design of the water passage immediately downstream from the valves and the pressure within this passage were the two main factors influencing the cavitation characteristics of an installation. One of the most effective means of eliminating cavitation damage below gate valves was the placing of sudden enlargements in the pipe sections immediately downstream. No damage could be detected in the concrete lining of the sudden enlargement under heads up to 150 ft with back pressures of approximately 15 ft, although noise similar to that which accompanies cavitation was present at heads in excess of about 90 ft.

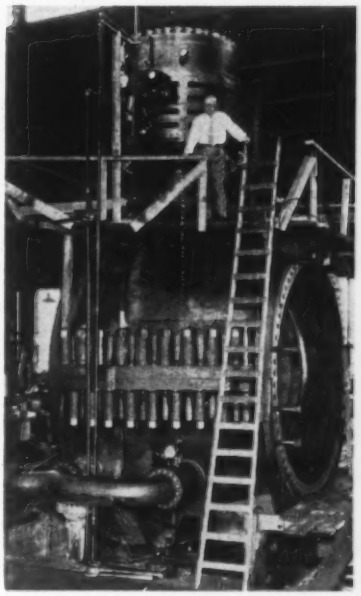
A limited number of tests were made to study the resistance of rubberlike products to cavitation erosion and their use in protecting the downstream pipe wall against this erosion. The conclusion was reached that such protection should not be used except in cases where cavitation will be mild.

Some consideration was given to venting the area in the top of the pipe just downstream of the valve, but this was considered objectionable because of the influence of entrained air on flow conditions and measuring devices, particularly propeller meters, placed downstream. Moreover, it was doubtful that air admitted to this region would reach all critical zones of local cavitation.

The information obtained from the valve investigation is very useful as design criteria for irrigation-distribution systems where valves are used for regulating the releases.

Development of Hydraulic Operation for Gates and Valves, by W. H. Kohler, Mem. ASME, U. S. Bureau of Reclamation, Large Gates and Valves Section, Denver, Colo. 1956 ASME Fall Meeting paper No. 56—F-8 (multilithographed; available to July 1, 1957).

RECENTLY the development of modern hydraulic equipment was spurred by the need for simple, compact, powerful, and reliable operating devices. It has been the development of auxiliary equipment, such as pumps, special types of valves, and electrohydraulic devices that has made possible the vast advances in hydraulic operation and control in the past 20 years. The addition of control to the brute force of the hydraulic cylinder to form an integrated unit is responsible for many of our modern machines and devices.



Fourteen-foot butterfly valve installed at Hoover Dam. A torque mechanism was designed and used for operating these valves. This involves an entirely new approach. The large rotor for the fourteen-ft valve has a torque capacity of over 25 million in-lb.

While the use of hydraulic equipment for operating gates and valves is not as spectacular as the hydraulic transmission, brakes, and steering on an automobile, the use of hydraulic operation and control has, nevertheless, been an important factor in solving many gate and valve control design problems at the Bureau of Reclamation.

This paper summarizes the growth in the use of hydraulic operation during the past 25 years and describes new applications at Hoover, Grand Coulee, Shasta, and Palisades Dams. There are also discussions of latch problems, developments for Australian hoists, and recent changes in the Grand Coulee system, and a brief review of the application of hydraulic operation and control of gate hoists and valves at the Bureau of Reclamation.

Machine Design

Calculating the Size of Flywheel Required for a Synchronous-Motor-Driven Reciprocating Compressor, by M. N. Halberg, General Electric Company, Schenectady 5, N. Y. 1956 ASME Fall Meeting paper No. **56—F-18** (multilithographed; available to July 1, 1957).

THE periodically pulsating torque of a reciprocating compressor produces pulsations in the current drawn by the driving motor. Unless proper flywheel effect is provided, the current pulsation becomes excessive; this may damage the motor and would often produce objectionable voltage variations on the power system. Calculation methods and data are presented in this paper which facilitate the determination of the proper flywheel effect.

Methods have long been available for determining the relation between current pulsation and the flywheel effect of synchronous motors driving reciprocating compressors. The calculation methods presented in this paper are derived from the same fundamental relations that formed the basis of previous solutions to the problem. However, the equations developed show more directly the relation between current pulsation and compressor factors, include certain refinements which were neglected in some solutions, and are given in terms of up-to-date motor constants. In addition, tables and graphs giving pertinent data are included and sample calculation forms are shown all designed to speed up the work and reduce the possibilities of error.

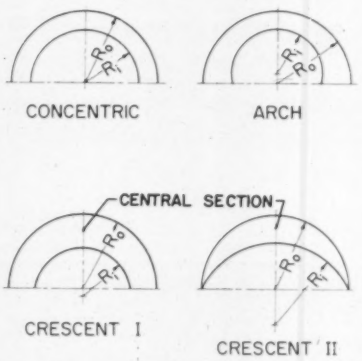
Tables of Functions for Short Cylindrical Shells, by R. B. McCalley, Jr., Knolls Atomic Power Laboratory, General Electric Company, Schenectady, N. Y., and R. G. Kelly, Applied Physics Laboratory, The Johns Hopkins University, Silver Springs, Md. 1956 ASME Fall Meeting paper No. **56—F-5** (multilithographed; available to July 1, 1957).

IN MOST instances the proportions of thin-walled cylindrical shells are such that the theory for a semi-infinite shell may be used. However, the case frequently arises in which the shell length is so small that the effect of boundary conditions at the far end cannot be ignored and the theory for finite shells must be employed. (Generally, a shell is classified as thin if its wall thickness is less than one tenth of the radius while the semi-infinite theory is considered reasonable if the shell parameter $n = \beta l$ exceeds five.) While solutions for finite shells are found in standard works, the complication of the formulas often discourages their use. The tabulated functions given in this paper will be found useful in reducing some of the tedium associated with the analysis. Any cases of uniform or hydrostatic loading can be solved by appropriate superposition of the four fundamental solutions in the tables. These functions have been calculated for specified deformations on the shell boundaries rather than in terms of specified forces since the former approach lends itself to analysis by the slope-deflection method or the Hardy Cross relaxation method.

Curved Beams With Eccentric Boundaries, by J. P. Vidosic and J. C. Durden, Georgia Institute of Technology, Atlanta, Ga., and F. J. Bogardus, Purdue University, Lafayette, Indiana. 1956 ASME Fall Meeting paper No. **56—F-1** (multilithographed; to be published in Trans. ASME; available to July 1, 1957).

THIS paper is a study of curved beams having eccentrically positioned circular-arc boundaries. The study involves some mathematical considerations as well as a photoelastic investigation of the stresses in such beams. The results comprise a method of design using the ordinary straight-beam theory but involving stress factors. Both curves and expressions that can be used to obtain the required factors are presented.

The ordinary type of curved beam is bounded by two concentric arcs; i.e., arcs having the same center of curvature. In the case of the eccentrically curved beam the two bounding arcs have different centers of curvature. In addition, it is possible for either radius to be the larger one. The one in which the section depth shortens as the central section (the section at the line joining the two centers) is approached is named the "arch beam." The other in which the section depth lengthens is named the "crescent beam." Crescent beams are further subdivided into two classes based on whether the outside or inside radius is the longer one. Crescent I is used to denote the beam of larger outside radius and crescent II of larger inside radius.



Several types of curved beams with eccentric boundaries

Kinematic Analysis and Synthesis Using Collineation-Axis Equations, by W. J. Carter, Mechanical Engineering Department, The University of Texas, Austin, Texas. 1956 ASME Fall Meeting paper No. **56—F-4** (multilithographed; to be published in Trans. ASME; available to July 1, 1957).

THE angular accelerations of the crank and lever of a four-bar mechanism have been related herein to the velocity of their rotopole through an equation developed by Koenig ("A Uniform Method for Determining Angular Accelerations," by L. R. Koenig, Trans. ASME, vol. 68, 1946, pp. A-41 to A-44). It is shown that the Koenig equation may be transformed in a simple manner into the collineation-axis equation derived by Freudenstein ("On the Maximum and Minimum Velocities and the Accelerations in Four-Link Mechanisms," by F. Freudenstein, Trans. ASME, vol. 78, May, 1956, pp. 779–787).

Other collineation-axis equations are here derived which permit a direct solution for the angular acceleration of the connecting link of a four-bar mechanism. These equations are differentiated with respect to time yielding fairly simple equations for the determination of the third time derivatives of lever and connecting link motions. The collineation-axis equations are further employed to determine the families of four-bar mechanisms, which satisfy the first three derivatives of a Taylor's series expansion of a desired functional relation between the crank and lever rotations. The fourth time-derivative relation for these mechanisms is then determined using the complex-number vector notation. Finally, the solutions are given to example problems of kinematic analysis and synthesis.

An Application of Complex Geometry to Relative Velocities and Accelerations in Mechanisms, by G. H. Martin, Michigan State University, East Lansing, Mich., and M. F. Spotts, Mem. ASME, Northwestern University, Evanston, Ill. 1956 ASME Semi-Annual Meeting paper No. **56—SA-32** (multilithographed; to be published in Trans. ASME; available to April 1, 1957).

THIS paper describes an analytical method for determining velocities and

accelerations in mechanisms by means of geometry of the complex plane. In addition to analysis of the four-bar linkage, a special solution is worked out for direct-contact mechanisms. The latter is included because, though accelerations in direct-contact mechanisms can be analyzed in terms of their equivalent four-bar linkages, there are certain cases where it is explained that the four-bar-linkage analysis breaks down. Further, it is shown that the method is general and is applicable to any mechanism having plane motion including complex mechanisms which cannot be treated as a series of four-bar linkages.

The Geometry of Belt and Chain Drives, by J. D. Howell, Mem. ASME, Walker-Turner Division, Kearney & Trecker Corp., Plainfield, N. J. 1956 ASME Semi-Annual Meeting paper No. **56—SA-41** (multilithographed; available to April 1, 1957).

PROBLEMS involving the geometry of belt and chain drives have always been considered difficult and tedious because of the complexity of the standard formulas connecting center distance, pulley diameters, and belt length. After demonstrating the derivation of the standard formula, the author derives new formulas using functions of the involute, which greatly simplify the calculation of many such problems.

The involute formula is applied in this paper in problems where one pulley is unknown, where crossed belts are involved, and where both pulleys are unknown, but the ratio given. The involute method is also applied to drives using a toothed belt and to chain drives.

A chart is given for solving for the angle between the belt or chain and center line of pulleys with the belt length, center distance, and ratio known. The derivation of this chart is also discussed.

Finally, the author presents complete tables of the involute function for use with his formulas.

Cost Criteria of Design Change in Industrial Products, by J. E. Ullmann, Bulova Research and Development Laboratories, Inc., Woodside, N. Y. 1956 ASME Semi-Annual Meeting paper No. **56—SA-42** (multilithographed; available to April 1, 1957).

EQUIPMENT vendors' labor and, to a lesser extent, material costs are shown to be the important cost criteria in the adoption of design changes in industrial products. Electric induction motors are taken as an example because they are manufactured in large quantities and by many manufacturers; they are standardized as to size and performance characteristics, and they are widely available in the United States market at prices which do not vary greatly from one manufacturer to the next for the same consumer class.

Definitions of the two major classes of change are suggested. The first is the "external" type. It occurs when a new design feature is added as an optional accessory or establishes a new class of equipment, coexisting with a previous design, at least for a time. The decision to make an external change amounts to deciding on a new product rather than on changing the old. The second type is the "internal" change.

A table is presented which shows the two groups of interests which are affected by product design: the users and the producers. To the users the most important cost effects are lower maintenance cost, lower first cost, and more safety, the latter being important because of its determining influence on insurance of workers and plant. The producer is interested in lower material and labor costs which together account for more than half of total manufacturing costs. The table gives possible design changes and their results in terms of the above variables.

The mechanical and electrical design changes during the past 25 years are then identified and their effects on producers and users are noted. Their occurrence is then correlated with changes in the labor cost and productivity pattern. The method may be suitable for other products where data can be made available, and it may be possible to predict change patterns in hitherto untouched machine elements. This is a matter of importance in many industries, particularly in those which may be faced with wholesale changes in the character of the product.

Load-Carrying Capacity of Spur-Gear Teeth Hob Cut From Molded du Pont "Zytel" 101, by K. W. Hall, Mem. ASME, and H. H. Alvord, University of Michigan, Ann Arbor, Mich. 1956 ASME Semi-Annual Meeting paper No. **56—SA-43** (multilithographed; available to April 1, 1957).

NONMETALLIC gears have been made and used for a long time. The qualities of the various materials used for them often include quietness of operation, ability to absorb shock loads, resistance to corrosion, and ability to operate with numerous fluids used as lubricants. When such gears can be molded to their final form, ease of manufacture becomes a very important quality of the nonmetallic gear. Zytel 101 is one new plastic molding material which makes it suitable for gears and similar mechanical parts.

This paper presents a method of calculating the load-carrying capacity of spur-gear teeth hob cut from molded du Pont Zytel 101, both with and without lubrication. The method is based on results obtained by testing seventy-two gears in five "back-to-back" test machines. Breaking strength and wear rates of the teeth, with and without lubrication are presented.

Zytel is thermoplastic. Molded, it is relatively lightweight, rigid, but not brittle. It is made in several varieties, of which Zytel 101 is the most heat resistant and best suited for mechanical parts. It is easily machined in the molded form. These are considerably affected by temperature and by moisture content of the molded material.

Results of the tests showed that when the teeth are lubricated, the load-carrying capacity of the teeth is governed by the breaking strength of the teeth and not by the rate at which the teeth wear. This same thing is true of the nonlubricated teeth, although the life of the teeth prior to breaking is considerably reduced when no lubrication is provided. When the teeth are cleaned with a solvent prior to operation, however, load-carrying capacity is greatly reduced and is governed by the rate at which the teeth wear rather than by breaking strength.

When lubricated, the teeth fail at the root in a manner that has the appearance of a typical bending-fatigue failure. At lower torque loads, failure occurs at a successively greater number of cycles, again indicating fatigue failure. Bending stress in the teeth was calculated by the basic Lewis equation.

When the teeth are not lubricated and failure occurs, the bending-stress calculations used with the lubricated teeth are not applicable. The torque capacity is considerably reduced when no lubrication is provided.

During the test, the gears were not visibly affected by normal temperature and humidity changes.

With or without lubrication, the torque lost due to friction in the teeth was small, and the friction torque tends to increase as the gear teeth wear with continued operation.

Inaccuracies in tooth form and thickness caused by continued wear did not seem to affect the operation of the gears in any way, except for the tendency for the tooth friction to increase somewhat. This may indicate that gears made of Zytel 101 do not need the same degree of tooth accuracy required by some other materials.

Ultrasonic Impact Grinding, by P. J. Duran, Raytheon Manufacturing Company, Waltham, Mass. 1956 ASME Semi-Annual Meeting paper No. 56—SA-47 (multilithographed; available to April 1, 1957).

ULTRASONIC impact grinding, a method for pounding accurately shaped holes in hard substances, employs an electromechanical transducer to convert alternating electrical current into mechanical motion.

The vibrations are converted into impacts by using a metal that stretches and contracts when placed in a varying magnetic field. This stretching and contracting of the transducer material applies impacts at a rate of 25,000 per sec to the shaping tool and hence to the workpiece.

Heat Transfer

Mollier Diagrams for Water Near Bubble Point, by Andre van Haute and B. H. Sage, Department of Chemical Engineering, California Institute of Technology, Pasadena, Calif. 1956 ASME Fall Meeting paper No. 56—F-9 (multilithographed; to be published in Trans. ASME; available to July 1, 1957).

IN MANY problems of engineering interest a knowledge of the thermodynamic properties of water in the heterogeneous region near bubble point is of value. A series of Mollier diagrams for water at states from bubble point to a quality of 0.05 was prepared and similar diagrams relating to the behavior of the condensed liquid are included in this paper, also. The Mollier diagram is employed because of its utility in connection with graphical operations of a thermodynamic nature pertaining to the flow of homogeneous and heterogeneous fluids near bubble point. An example of the application of the diagrams to the solution of the simple problem of flow in short tubes is included.

Determination of Thermal Conductivities of Metals by Measuring Transient Temperatures in Semi-Infinite Solids, by S. T. Hsu, Mem. ASME, Mechanical Engineering Department, University of Dayton, Dayton, Ohio. 1956 ASME Fall Meeting paper No. 56—F-11 (multilithographed; to be published in Trans. ASME; available to July 1, 1957).

VARIOUS methods have been devised in the past for measuring the conductivities of metals at ordinary or higher temperatures. Fundamentally they can be classified into two categories, namely, the steady methods and the transient methods. The former usually determine the conductivities while the latter give the diffusivities. The steady methods often involve the measurement of heat quantity which results in a real problem on the elimination of heat loss. The time required for testing is also rather long. In transient methods, the changing temperatures instead of heat quantity are measured. But for the several methods developed in recent years, the testing specimens are mostly in the form of long rods or wire, which are not always available in certain metals. Furthermore, they usually require much longer time for the measurement.

It has been a difficult task to maintain a constant temperature at the end of a rod or wire, or on one side of a plate for the duration of the test. This problem is solved in this method by bringing two plates together so that the temperature at the contact plane remains constant during the testing period.

The temperature on the flat side of the semi-infinite solid is suddenly raised to a certain value. Then at two stations inside the solid, the temperature variations with time are recorded by means of thermocouples, a string galvanometer, and synchronized photographic equipment. Both the thermal conductivity and specific heat can be determined in the same experiment. The time for measurement is only 30 sec. The result is estimated to be accurate to within 2 per cent for certain metals.

Turbulent Free-Convection, Heat-Transfer Rates in a Horizontal Pipe, by J. P. Fraser and D. J. Oakley, Assoc. Mem. ASME, Knolls Atomic Power Laboratory, General Electric Company, Schenectady, N. Y. 1956 ASME Fall Meeting paper No. 56—F-6 (multilithographed; to be published in Trans. ASME, available to July 1, 1957).

HEAT-transfer rates are reported for turbulent free convection in a finite-length horizontal pipe containing sodium. Heat is added at one end and removed at the other. A generalized equation which correlates the data is proposed, giving the ratio of heat transfer with turbulent convection to that on pure conduction in terms of the L/D ratio, Prandtl number, Grashof number, and Reynolds number. The solution is extended to inclined pipe with one or both ends open to plenums. The laminar and turbulent velocity and temperature profiles in a heat-generating fluid for a long vertical parallel-sided cell having isothermal walls have been evaluated analytically in the paper. The experimental investigation of heat transfer by free convection of a fluid in an isothermally heated vertical tube sealed at the lower end and open at the upper end to a cooled plenum is reported. Findings are in close agreement with theoretical predictions of Lighthill.

The flow pattern reported has no axisymmetry in contrast with the previously referenced work. It is hoped that the generalized solutions will extend the usefulness of the test data; also that their derivation will suggest additional experimental work clarifying the mechanism and providing the basis for an improved general solution.

Petroleum Mechanical Engineering

Materials Aspect of Some High-Temperature, Refinery-Piping Applications, by E. A. Sticha, Crane Company, Chicago, Ill. 1956 ASME Petroleum Mechanical Engineering Conference paper No. 56—PET-21 (multilithographed; to be published in Trans. ASME; available to July 1, 1957).

NEW developments in refinery processing have posed many problems for materials engineers through the years. The refining industry was one of the first to require metals for carrying out large-scale operations at high temperatures. It is the aim of this presentation to outline in a general way the materials most commonly used in these applications and to discuss more specifically some of the problems which have been encountered in the past ten years.

Materials for high-temperature service are selected primarily on the basis of their strength (short-time, creep, and rupture) although it should be evident that other characteristics such as ductility, corrosion and erosion resistance, structural stability, weldability, and so on must be adequate. It is fortunate indeed that many of these requirements are fulfilled in an economical manner by one basic material; namely, carbon steel. We are prone to overlook the versatility of carbon steel as offered by variations in method of manufacture, composition, and heat-treatment. So adaptable is this simple iron-carbon alloy that in some instances it is employed for temperatures up to 1100F though admittedly at low pressure and in reducing atmospheres.

Where greater fluid pressure must be contained in this temperature range, a higher-strength material is available in the form of carbon-molybdenum steel. Its field of greatest application is in the temperature range from 700 to 1100F.

Processing conditions often require greater higher-temperature corrosion resistance than is obtained with the two aforementioned steels and, to meet this

need, a wide variety of chromium-molybdenum alloy steels is available.

In some cases straight chromium steels of greater alloy content have been employed to cope with particularly corrosive fluids.

For extreme-pressure conditions, occasionally to temperatures as high as 1500 F, engineers often have resorted to use of the austenitic chromium-nickel steels because of their high creep and rupture resistance. These steels contain 18 per cent or more chromium with 8 per cent or more nickel and may be modified by additions of other elements to confer special characteristics.

Electrification of Oil-Well Drilling Rigs—Using Transportation-Type Equipment, by F. A. Compton, Jr., Mem. ASME, and C. D. Neithamer, Associate Mem. ASME, General Electric Company, Erie, Pa. 1956 ASME Petroleum Mechanical Engineering Conference paper No. **56—PET-26** (multilithographed; available to July 1, 1957).

As OUR economy has expanded over the years, petroleum has played an ever-increasing role in this expansion. Consumption and production of oil are presently at their highest level, and by 1975 we will be producing almost twice as much crude oil as in 1953.

The petroleum industry is constantly striving to improve production efficiency in order economically to meet this increasing demand for oil. One of the recent advances in increased efficiency is the use of diesel-electric or gas-electric equipment for drilling rigs—this can go a long way toward reducing the contractor's operating costs.

The use of electricity for drilling power is not new to the drilling industry. The main reason drilling rigs have not been electrified more rapidly is that in the past the initial cost of the equipment was not attractive.

Today, an entirely new approach to drilling-rig electrification is available—the use of standardized, transportation-type equipment. These d-c motors, generators, and control were developed and mass-produced for thousands of diesel-electric locomotives. The use of this equipment offers advantages never available before.

The power needs of a drill rig are quite similar to those of a locomotive since it requires variable speed, variable torque, and variable horsepower.

Mass production of these components for the railroad market makes a low-cost, electric-drive package available for drill-rig service. Studies indicate that present prices are approximately one half those of the individually designed earlier equipment.

The advantages of electric drive for drill rigs are: (1) Speed—greater flexibility and smooth power application, more "hole" per dollar; (2) Reliability—thoroughly proved in locomotive service; (3) Easy maintenance—few wearing parts, no alignment problems; (4) Remote location possible—easier rig construction, less fire hazard, noise, and vibration; (5) Portability—easy rig-up and tear-down; (6) Efficiency—power-transmission losses are minimized.

The heart of this system is a d-c traction motor. Its use on even the smaller rig loads proves advantageous because of its relatively low cost and its interchangeability. The motor rates 600 hp at 900 rpm continuously, and 800 hp at 900 rpm intermittently for hoisting-cycle duty. Electrically, it is the same as the railroad motor with the exception of the field, which has been changed from a series to a shunt winding.

The generators have been designed for either offshore or land applications.

Much of the control for the drilling equipment is inherently built into the generators and motors. The main control compartment is of weatherproof construction and can be pressurized, if desired.

Semi-Automatic, Gas-Engine-Driven Centrifugal, Gas-Compressor Station, by G. B. McIntosh, Jr., Transcontinental Gas Pipe Line Corporation, Houston, Texas. 1956 ASME Petroleum Mechanical Engineering Conference paper No. **56—PET-28** (multilithographed; available to July 1, 1957).

TRANSCONTINENTAL Gas Pipe Line Corporation in early 1956 placed in operation on its system a 3000-hp, gas-engine-driven, centrifugal-compressor booster station, one of the first applications of this combination of equipment in a natural-gas pipeline-compressor station.

Station 23 is unusual in that it uses the gas engine to drive a centrifugal compressor through a geared speed increaser. This combination is one of the first of its type to be utilized in a natural-gas, pipeline-compressor station.

While centrifugal compressors have been used in numerous ways by the pipeline industry, the selection of the four-cycle engine as a driver makes the installation unique. The station was designed as a main-line booster, making centrifugal-compressor equipment with its low ratio of compression ideally suited for this application. The low fuel consumption of the four-cycle engine is also attractive.

Station 23 has been designed with flexibility and ease of operation in mind. It has an exhaust-driven turbocharger and a variable-intake valve control that is actuated by the exhaust temperature. Engine speed varies from 450 to 500 rpm.

The centrifugal compressor is designed to handle volumes of gas ranging up to 550,000,000 cu ft per day. Differential across the station should range from about 60 psig up to 100 psig, depending on the volume of gas.

With the control features designed into the station, it can be operated unattended 16 hours out of each 24-hr period.

All of the oil systems—gear oil, compressor lube oil, and turbocharger oil—are self-contained and are not connected to the engine-oil system. The hot system circulates water for cooling the engine jackets and the engine lube oil.

The starting-air system and fuel-gas systems are conventional, with most of the equipment located in the compressor-building basement and the meter building. The utility and domestic-water systems are equipped with pressure tanks and the utility and water-well pumps run intermittently as needed. A sprinkler system has been installed in the plant yard to water the entire plant area.

Electric power is purchased and no emergency generating equipment has been provided. All main switchgear is located in the office building, including direct-current batteries, which are used as part of the emergency shutdown protection.

The paper concludes with an interesting discussion of the safety features of the station.

Design and Selection of Motor Operated Valves, by A. Brothman, Techniflex Manufacturing Company, Inc., Port Jervis, New York. 1956 ASME Petroleum Mechanical Engineering Conference paper No. **56—PET-32** (multilithographed; available to July 1, 1957).

IN PIPELINE practice, valves are used in modulating-control duty as one basic class and in shutoff "on-off" duty as the second basic service. Modulating-control duty in response to control signalling by high-level servo-type instrumentation is common in connection with constant-speed booster pumps where the control valve serves to establish the differential pressure across the pumps and in back-pressure control where control valves are used at terminal points to maintain desired hydraulic gradients at flow traffic points. Shutoff duty is encountered: (1) in connection with storage tank selection in multi-tank hold-up or receiving-tank installations;

(2) in establishing traffic control at gathering, transfer, distribution, and delivery points; (3) in isolating booster pump stations from a pipeline; and (4) in establishing flow-traffic control in connection with interfaces between successive differing crudes or different products.

In the matter of modulating-control valves, arguments are developed for the superior applicability of instrument-responsive electric-motor valve operators in pipeline applications. Here, the arguments include an analysis of pipeline frequency-response requirements, the insusceptibility of electric-motor valve operators to disk-displacement by dynamic unbalance conditions, and the minimized maintenance requirements of electric-motor valve operators as compared with conventional pneumatic valve operators. To these considerations, there can be added the immunity of electric motor operators to high humidity and freezing temperature conditions.

In the case of shutoff valves, an analysis is made of valve according to stem stroke motions. In the absence of adequate data to permit the computation of shutoff sealing requirements, a method of selecting operators by the torque-transmission capabilities of valve stems is proposed. Analytically derived expressions are furnished for computing maximum operator torque requirements for the basic stem motions. Recommendations affecting the application of braking in high stroke speed applications and improvements in torque switch devices are also made.

Lease Automatic Custody Transfer, by S. H. Pope, Gulf Oil Corporation, Tulsa, Oklahoma. 1956 ASME Petroleum Mechanical Engineering paper No. **56—PET-33** (multilithographed; available to July 1, 1957).

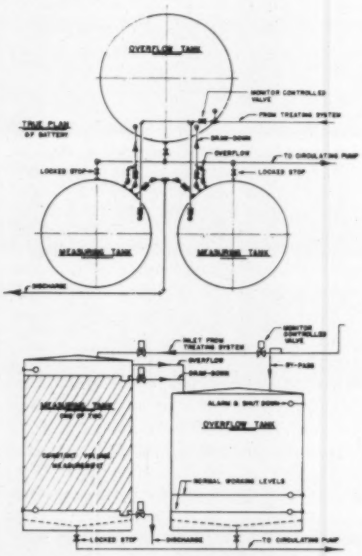
THE profitable application of automatic controls to producing leases, tank batteries, pipelines, and refineries is an accepted fact. Only custody transfer of oil from lease tanks to gathering system has resisted automation. To permit completely automatic operation from wellhead through refinery, a great deal of work is being done to provide automatic measurement and sale of oil from lease to connecting pipeline on an unattended basis. The name "Lease Automatic Custody Transfer" has been given to this method of oil handling.

The fact that the automatic measurement and sale of oil has resisted automation for so long is an indication of the problems involved. There are five basic requirements: (1) Accurate measurement, (2) accurate determination of BS&W, (3) accurate determination of gravity, (4) accurate determination of temperature, and (5) assurance that the oil delivered is merchantable.

The tremendous interest in Lease Automatic Custody Transfer is proof that the advantages to both producer and transporter will be appreciable.

At the present time there are either on test, in actual operation, or under consideration, four methods for accomplishing lease automatic custody transfer. These four methods are as follows: (1) Tandem Metering and Storage (surge tank and one measuring tank); (2) Parallel Metering Tanks (two parallel alternating measuring tanks); (3) Positive Displacement Metering (API-ASME Code No. 1101-Petroleum P.D. Meter Code); and (4) Measurement by Weight (equal increments of weight).

At the present time in Kansas, oil is being delivered to a pipeline from a lease automatic custody transfer battery. This system is believed to be the first in domestic operations to deliver oil automatically on an unattended basis. Operation has been satisfactory.



In this system of automatic custody transfer, oil flows from the treating system to one of two parallel alternating measuring tanks. These tanks deliver constant gross volume dumps between fixed levels termed "weirs." The number of gross volume dumps is recorded, temperature of each dump is recorded, and a proportionate sample is taken for determination of API gravity and BS&W. Automatic sale of crude oil is recorded periodically on a standard-run ticket substantiated by two temperature charts and one oil-height chart.

Lease automatic custody transfer is a method that work to date has proven to be feasible. At the present time, to further its general acceptance, it is necessary that more producing and pipeline companies gain additional firsthand knowledge through actual automatic custody transfer. It is now up to industry to take full advantage of this new tool that will permit completely automatic operation from wellhead through refinery and, in so doing, result in a reduction in producing and oil-handling costs.

Strength Characteristics of Rock Samples Under Hydrostatic Pressure, by R. O. Bredthauer, Hughes Tool Company, Houston, Texas. 1956 ASME Petroleum Mechanical Engineering Conference paper No. **56—PET-23** (multilithographed; to be published in Trans. ASME; available to July 1, 1957).

FOR many years, it has been known that laboratory drilling-rate tests did not agree with the results of field tests, even when it was known that the formations were the same. It was generally felt that the fluid pressure exerted by the mud column above the formation being drilled must have an important effect. Thus, a bit designed to perform quite well in the laboratory under atmospheric pressure may perform unsatisfactorily, and uneconomically, in the field under more practical conditions.

Other investigations have shown that rock cylinders exposed to hydrostatic pressures of 10,000 atmospheres and loaded axially in compression behave in a ductile fashion as contrasted with their brittle behavior when tested in axial compression at atmospheric pressure

The purpose of this work is to study the effect of hydrostatic pressures in the range 0 to 15,000 psi upon cylindrical rock samples when loaded in axial compression. This is equivalent to pressures exerted by drilling muds upon the face of formations exposed to the cutting action of rock bit teeth.

Results of tests are presented as stress-strain curves. In those cases where all tests at a given confining pressure were consistent, an average curve is presented for the particular condition. When single tests deviated, the stress-strain curve for the deviating test was also plotted.

An appendix gives a tabulation of the types of failures which occurred at various confining pressures.

A summary of the effect of hydrostatic confining pressure upon the compressive strength of the various formations is shown in the figure. Forma-

tions have been grouped according to their behavior—ductile, borderline, or brittle—for the confining pressure range 0 to 15,000 psi.

All formations which experienced a brittle-to-ductile transition have relatively low compressive strengths at atmospheric pressure.

Low-strength formations are indeed best drilled when using rock bits which have long, widely spaced teeth and which provide a tearing-gouging action.

The higher-strength formations, which remain brittle up to 15,000-psi confining pressure, are best drilled using heavy-weight practice and rock bits providing a crushing-rolling action.

Another fact of importance is illustrated in the figure. The compressive strength of all formations was increased considerably with increasing confining pressure, including the stronger formations such as Knippa basalt and Virginia limestone.

In conclusion:

1 Increases in compressive strength with increasing confining pressure were obtained on all formations tested in the dry, jacketed condition.

2 Brittle behavior was obtained at atmospheric pressure on all formations tested in the dry, jacketed condition.

3 A brittle-to-ductile transition was obtained in the confining pressure range 0 to 15,000 psi on Anhydrite, Carthage marble, sandy shale, coarse Chico limestone, and shale specimens.

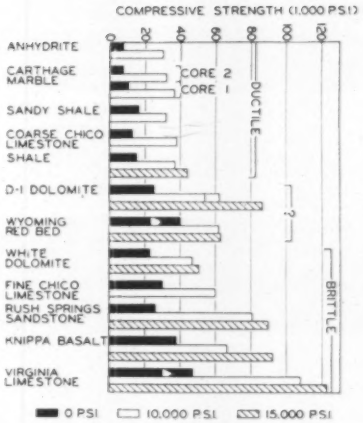
4 Formations which appeared to be near the brittle-to-ductile transition at 15,000-psi confining pressures were D-1 dolomite and Wyoming red bed.

5 Brittle behavior was obtained at all confining pressures to 15,000 psi on White dolomite, fine Chico limestone, Rush Spring sandstone, Knippa basalt, and Virginia limestone.

6 Fracturing of rock exposed to hydrostatic pressure in many cases is dependent upon the deformation as well as the stress which is imposed upon the formation. Thus, in formations which become ductile under pressure, large amounts of flow must occur before fracture is achieved, and ultimate removal of the rock is accomplished.

On Porosity and Rock Strength, by A. D. Topping, Goodyear Aircraft Corporation, Akron, Ohio. 1956 ASME Petroleum Mechanical Engineering Conference paper No. **56—PET-27** (multilithographed; available to July 1, 1957).

THE purpose of this work is to extend the discussion of two earlier papers on rock strength by Mr. Topping, to explain



Bar graph summarizing results of compression tests at 0, 10,000, and 15,000-psi confining pressures

certain phenomena encountered in the triaxial testing of rock, and to show their practical significance. The first of these papers pointed out the importance of a systematic investigation of rock strength to the drilling engineer, and suggested ways to predict both yielding and fracture which are somewhat at variance with better known theories of strength. The second presented data from triaxial tests by various investigators on jacketed specimens of marble in support of the new approach, and showed how the physical constants needed in its application can be obtained from the data. The concept of octahedral stress and strain is used in both papers, and likewise is used here. The octahedral planes are those which make equal angles with each of the principal-stress axes. Any set of principal stresses can be resolved into an octahedral normal stress (which is the same as a hydrostatic or volumetric stress) and an octahedral shearing stress (which has the same magnitude on each of the octahedral planes also). Failure is best understood in terms of these stresses or the corresponding strains; fracture, in general, can be better understood in terms of strains.

Triaxial tests of jacketed specimens of rock show that, unlike metals, their strength is a function of hydrostatic pressure. Similar tests of unjacketed specimens, on the other hand, show that, when a pressure-exerting fluid has direct access to the surface of the rock, no corresponding change in strength occurs. At very high pressures, however, the behavior of the two types of specimens is reversed. The reasons for these phenomena and their significance for drilling problems involving rock strength are discussed.

The Maintenance Challenge in a Petrochemicals Plant, by P. S. Skaff, E. I. du Pont de Nemours & Company, Inc., Polychemicals Department, Orange, Texas. 1956 ASME Petroleum Mechanical Engineering Conference paper No. **56—PET-2** (multilithographed; available to July 1, 1957).

AN ANALYSIS of the maintenance function in modern and complex industrial plants of today will reveal several trends of marked significance.

The portion of the cost-of-production dollar attributable to the maintenance of the plant is growing at a faster rate than are other elements of cost.

Another important trend is that of the influence of maintenance techniques upon the quality of the product.

The increase of equipment per employee means increased use of automatic control; and of course these automatics must be kept in perfect order to do their job. This demands intelligent and adequate maintenance, applied in such a way that a minimum of process downtime is necessary.

This paper covers the maintenance program and its results at a petrochemicals plant in southeast Texas. Maintenance influences on cost and production are reviewed, and the organization and cost-reduction program to control these influences are outlined. Also specific experience is covered in some detail so as to present a picture of the relative magnitude of the many types of maintenance in a plant such as this.

Experience With Positive Displacement Meters in Oil Pipe Service, by D. C. McKinley, Mem. ASME, Interstate Oil Pipe Line Company, Shreveport, Louisiana. 1956 ASME Petroleum Mechanical Engineering Conference paper No. **56—PET-20** (multilithographed; available to July 1, 1957).

THIS paper has been prepared to transmit observations and information obtained from the actual use of positive-displacement meters in oil-pipeline operations. It is intended to be beneficial to those in industry who are interested in measuring crude oil by the positive-displacement-meter method in production and refining as well as in transportation operations.

The material and basic information included herein is based on operating experiences extending over a 4-year period during which time positive-displacement meters were introduced, tested, and adopted as a desirable measuring facility. The extent of meter acceptance perhaps can be realized better by considering the fact that in 1952 three small meters were in operation for test

and observation purposes only. Today there are approximately 60 meters in operation measuring approximately 400,000 bbl per day, of which 375,000 bbl per day are custody-transfer measurements.

Experience with positive-displacement meters in oil-pipeline operations has demonstrated beyond a doubt the reliability and accuracy of this type of measurement facility. Fluids with a wide range of characteristics such as gravity, viscosity, wax content, and Reid vapor pressure have been measured successfully from trunks at the production-lease and trunk-line terminals. Over 140 million barrels of crude oil have been metered at terminals with a highly satisfactory maintenance and operating-experience record. Larger-capacity metering facilities are being developed and should be tested in 1956. Increased use of meters is expected.

Design of Manifold Fittings for Special Temperature and Pressure Conditions, by W. R. Wollering and A. J. Vazquez, Ladish Company, Cudahy, Wisconsin. 1956 ASME Petroleum Mechanical Engineering paper No. **56—PET-34** (multilithographed; available to July 1, 1957).

DESIGNERS and builders of equipment used in processing crude-oil derivatives, more specifically, equipment for improving gasoline-octane value, who require piping to carry vapors or liquids through a heating chamber have, for many years, used manifolds for connecting tubes. The manifold, basic design for joining parallel flow paths, is also used widely in pipeline service for gas transmission across rivers, and at compressor stations to provide suction and discharge access to paralleled compressors. Another manifold type acts as a surge chamber to minimize pressure pulsations. There are an infinite number of applications for this basic design.

Infinite in application as the manifold may be, its method of manufacture determines its suitability for use at high temperatures and pressures. The method of fabrication utilizing the welded branch connection and reinforcement by pads, saddles, and increased weld section has received considerable attention since failures have been associated with this design. Extensive stress measurements have been made to correlate the reinforcement design with stress intensification and failure. As a result of this weakness, leaders in the gas industry have set up safety rules for application, design, and fabrication of welded branch connections.

Paralleling these developments, there occurred a design review of process piping operating at high temperature and pressure. One of the components was the welded manifold. Designers recognized the sharp transition in flow between tube and header as a deterrent to flow efficiency. Their plans challenged manufacturers of fittings to produce manifolds with integrally formed nozzles. From the development of multiple-outlet headers with the nozzles all in one plane, tools, dies, and heating procedures had to be developed to form larger manifolds with outlets in different quadrants.

This latter development came as a result of major gas pipeline companies, faced with new construction at higher pressures, desiring connections having greater strength than that provided by a saddle-reinforced welded branch connection. One of these concerns expanded this idea by visualizing a more economical method of field assembly of a gate-valve setting. The result was the use of a manifold which reduced the flow from the 30-in. main line diam to a 20-in. diam for flow through the gate valve, and had 6, 8, and 12-in. formed nozzles in different quadrants for by-pass, blow down, and branch connections. A similar header restored the flow to the main line diam. The configuration allowed a 70 per cent decrease in assembly time over the same installation using saddle-reinforced welded branch connections, flanges, and bolt studs.

The integrally formed outlet manifold was designed to operate safely under conditions of high pressure where welded branch connections would be stressed beyond safe operating limits. Maximum measured stresses developed in the unreinforced welded branch connection are not reduced by saddle-type reinforcements which, for some designs, aggravate the situation. The formed manifold with capacity for multiple outlets of varied orientation fills applications that forged tees or full encirclement reinforcements cannot accommodate.

Both types, process piping and pipeline service manifolds, have been subjected by the authors' company to extensive analysis to evaluate their resistance to internal pressure loads. Process piping manifolds have been subjected to internal pressure at room temperature, and the stresses developed analyzed in relation to operation of the header at high temperature, wherein material type and its resistance to creep become important. Pipeline service manifolds have, in addition to internal pressure at room temperature, been subjected to the type of branch bending loads that can arise during installation and operation. An analysis of various designs of this type of manifold which have been subjected to combinations of internal pressure and external load is presented and discussed.

Application of Diesel-Electric Traction Power to Oil Well Drilling, by B. H. Hefner, General Motors Corporation, La Grange, Ill. 1956 ASME Petroleum Mechanical Engineering Conference paper No. **56—PET-25** (multilithographed; available to July 1, 1957).

A COMPREHENSIVE analysis of power and load requirements for oil-well drilling was conducted to determine the adaptability of proved diesel-electric-locomotive power components to all phases of drilling operations. The study revealed that the General Motors No. 567 two-cycle diesel engine and the series traction motor could be engineered into a versatile power unit well suited to both land and offshore oil-drilling operations.

The EMD 567-C diesel engine at full load operates at constant speed and constant torque. The draw works requires varying speed and varying torque. The problem, then, was to team the drawworks requirements with the operational characteristics of the engine in the best possible manner.

The figure shows the complete diesel-electric power unit.

This 8-cylinder, two-cycle, V-type diesel engine develops 875 hp at 835 rpm. Continuous torque is 5500 ft lb. These ratings are based on 90-F air intake and zero to 2000-ft altitude.

Flexibility, ease of control, the physical separation of prime mover and load, high efficiency, plus elimination of chain compounding and alignment are some of the advantages of diesel-electric power. With this type of rig, it is possible to operate the diesel engine at an optimum speed to provide adequate economical power. The electric transmission is an infinitely variable-speed changer that matches the output of the engine to the requirements of the load.

Multiple loads can be handled by one engine—mud pumps can be driven at one speed and the rotary table at another without necessity for gear-reduction complexity. The relationship of engine to load speeds is completely independent. Flexibility and versatility are exemplified by ease of connecting power to load through a selector switch for load choice, or by changing flexible cable leads which can be plugged in or disconnected with a minimum of time and effort.

Separation of power source from load permits extreme flexibility in economic arrangement of the engine-generator unit in relation to load units. This makes possible space savings up to several hundred square feet of expensive deck-space

area in offshore operations and land rigs, through elimination of the complexity of mechanical compounding and need for alignment.

The electrical transmission provides infinite speed control and extremely smooth and shock-free operation. Diesel-electric power offers highest efficiency.

Maintenance Welding High-Test Line Pipe, by A. M. Hill and F. W. Zilm, Service Pipe Line Company, Tulsa, Oklahoma. 1956 ASME Petroleum Mechanical Engineering Conference paper No. **56—PET-15** (multilithographed; available to July 1, 1957).

A TESTING program is described which was carried out at the authors' company's Tulsa shops to find a solution to the problem of underbead cracking of arc welds where branch connections and reinforcing sleeves are attached to the pipeline by welding. In these tests the welding was performed under conditions simulating, as nearly as possible, those encountered in the field. The tests consisted of making spot welds and welding various sized patches and full-encirclement sleeves on chambers fabricated from 24-in. OD pipe manufactured in accordance with API Specifications 5L and 5LX. All welding was done on test chambers cooled with a mixture of water, anti-freeze, ice, and salt. After welding was completed on the various chambers, the welds were inspected for underbead cracks either with magnetic particles, or by sectioning 100 per cent of the weld into coupons which were broken in the weld zone to expose the root bead. Several chambers were subjected to destructive tests by hydrostatic pressure.

The results of the tests show that the high-yield-strength pipe is very sensitive to the quenching effect of the liquid contained in the test chambers.

Hydrostatic tests conducted on chambers proved that fittings constructed to completely encircle the pipe will consistently withstand higher internal pressures than the reinforced saddle-type fittings.

By comparing the results of the various tests, a new welding procedure was established.

The authors' company adopted the following procedure for repair and maintenance welding on pipelines that contain oil or petroleum products:

Use fittings that completely encircle the pipe. This holds true regardless of pipe size, when welding is required for making repairs, or for installing new connections onto a line.

Use E7016 low-hydrogen iron-powder electrodes for all welds which are fused to the wall of the pipe.

The longitudinal seams of fittings designed to encircle the pipe shall be equipped with a steel backup strip to prevent the weld metal deposited in these seams from fusing to the wall of the carrier pipe.

Carefully check all completed welds for underbead cracks with dye-penetrant material.

The operating pressure in a pipeline at the location of welding shall be reduced to 200 psi before any welding is started. This pressure shall not be increased until all welding on a line is completed.

Performance of 6061-T6 Aluminum Flanged-Pipe Assemblies Under Hydrostatic Pressure, by H. H. George and E. C. Rodabaugh, Assoc. Mem. ASME, Division of National Cylinder Gas Company, Louisville, Ky., and Dr. M. Holt, Mem. ASME, Alcoa Research Laboratories, Aluminum Company of America, New Kensington, Pa. 1956 ASME Petroleum Mechanical Engineering Conference paper No. **56—PET-19** (multilithographed; available to July 1, 1957).

WHERE flanges are welded to pipe (welding neck and slip-on flanges) the heat of welding lowers the tensile properties of 6061-T6 material. This paper reports tests to determine what effect this reduction in tensile properties has on 6061-T6 flanged-joint performance and thus to provide a test basis for establishing suitable pressure-temperature ratings for 6061-T6 aluminum-alloy flanges made to dimensions given in ASA B16.5.

Aluminum and aluminum-alloy piping systems have proven to be most satisfactory and economical for certain applications, such as those in which (a) the operating temperature is very low, (b) the purity or color of the product must be maintained, and (c) the corrosion-resistant qualities of aluminum are required.

The principal part of the investigation described in this paper concerned 8-in., 150-lb and 12-in, 300-lb., welding neck and slip-on, 6061-T6 flanges along with comparative tests of 12-in. carbon-steel flanges, all flanges being dimensionally in accordance with ASA B16.5.

The tests indicate that 6061-T6 welding-neck flanges made to ASA B16.5 dimensions are essentially equal in strength to comparable carbon-steel flanges.

The tests also indicate that 6061-T6 slip-on flanges are significantly affected by the heat of welding, the severity varying with the welding procedure used and size of flange. It is felt that the available test data do not give a completely adequate basis for establishing ratings of 6061-T6 slip-on flanges; however, they do indicate that a rating of two thirds that of welding-neck flanges would probably be satisfactory.

The test procedure is described in detail and tables are presented containing all resultant material.

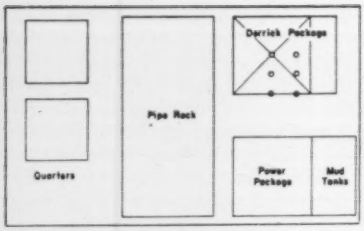
Prevention of Destructive Engine Failure by Spectrographic Analysis of Crankcase Oil, by R. E. Linnard, C. B. Threlkeld, and R. T. Blades, Mem. ASME, Phillips Petroleum Co., Bartlesville, Oklahoma. 1956 ASME Petroleum Mechanical Engineering Conference paper No. **56—PET-30** (multilithographed; to be published in Trans. ASME; available to July 1, 1957).

CRANKCASE oils of stationary engines operating in relatively constant service normally contain equilibrium but minute amounts of certain metals indicative of normal engine wear. The occurrence of abnormal wear or corrosion conditions in an engine is reflected in concentration of one or more of the key wear metals in the crankcase oil. These trends in metals content offer important and early clues concerning the abnormal events which are occurring and suggest the need for corrective action usually far in advance of destructive engine failure. Utilization of data from emission spectrographic analysis of crankcase oils has been found to have practical use in the surveillance of pipeline engine operations, particularly where the performance of copper-lead bearings has been in question. The application of this type of used-oil analysis as a practical aid in the prevention of destructive engine failures is reviewed, the interpretation of data is discussed, and examples of the relationship between increasing key wear-metals content and observed engine conditions are cited.

Practical Aspects of Using Diesel-Electric Railway Equipment on Drilling Rigs, by H. D. Redding, Phillips Petroleum Company, Houston, Texas. 1956 ASME Petroleum Mechanical Engineering Conference paper No. **56—PET-29** (multilithographed; available to July 1, 1957).

IN 1955 Phillips Petroleum Company decided to drill a well off the coast of Louisiana in 85 ft of water. It was decided to drill the well from a self-contained platform. Since platforms in this depth of water are expensive, large savings could be made by keeping the floor area to a minimum.

The objective was to design a rig arrangement that would allow a large rig



Arrangement of drilling platform for minimum floor area

to be placed in a small area, be able to drill six wells, and be moved in a short time.

To accomplish this, a diesel-electric rig was built in three large packages. Each package weighed less than 250 tons so it was handled with the existing derrick barges.

The 140-ft conventional derrick and 4-post, girder-type derrick substructure is one package.

The second package contains the mud pumps, the d-c and a-c generating equipment, air compressors, a-c generator control and power-distribution panels, d-c motor-control box, Schlumberger unit, welding machine, and day fuel tanks.

The third package is the mud tank package. It contains the mud tanks, shale shaker, pump suctions and valves, mud centrifuge, lightning mixers, chemical mixing tank, and the parts house.

The company believes that the way the rig is rigged up on their offshore platform has many advantages over the method of rig-up made necessary by a power rig.

The advantages of the diesel-electric rig that allowed this type rigging-up are:

1 Diesel electric power allows flexibility of placement of rig components.

2 Equipment is smaller, lighter, and more compact than the conventional power equipment.

2 Electrical power is more flexible than straight diesel power.

The maintenance on electrical equipment is very low. In addition, the engines run at a constant speed which should result in lower fuel, oil, and maintenance cost.

Traction equipment was used for this project instead of war surplus, which was cheaper, but bulkier.

Following are the reasons the company chose traction equipment:

1 Mass production of engines, generators, and motors for use in the railroad industry has brought the price down until it is competitive with a conventional power rig of the same capacity.

2 Motors and generators are small and light.

3 Equipment is new and has the latest improvements in design and materials. A warranty is provided to protect the user against defects.

4 Control systems are designed, furnished, installed, and serviced by the manufacturer.

5 Parts and replacements are readily available.

The rig has two 700-hp pumps. Each pump has one 625-hp electric motor mounted on the skid driving the pump through a chain drive.

When this rig was placed in operation, it was the first time that the traction equipment and controls were used on a rig equipped with a steam draw works and a direct rotary drive. A rig rigged up in this manner calls for good speed control and presents more problems of making and breaking contacts under load than a rig using a power draw works and a chain drive to the rotary.

The troubles encountered in actually using this equipment offshore and the future possibilities of diesel-electric equipment are discussed.

Problems Encountered in the Manufacture and Rating of Air Heat Exchangers, by James I. Carter, Arrow Industrial Manufacturing Company, Tulsa, Oklahoma. 1956 ASME Petroleum Mechanical Engineering Conference paper No. **56—PET-6** (multilithographed; available to July 1, 1957).

THE major problem encountered by the manufacturers of air-cooled, heat-exchanger equipment is the development of the purchaser's exact requirements. This consists of the performance, type construction, and evaluation.

In general an inquiry contains information relating to the performance as well as design pressure and temperature. Code-type construction is specified occasionally. Usually the actual construction is dependent on the manufacturer's practice or that of the industry. Normally, we would expect the fabrication to be defined when code construction is specified. However, the code as now written applies only to the header construction and design. Certain accepted practices as set forth by TEMA are not included in the code as now written. The code specifies the plate thickness, type plate material, and type weld. Since the code was actually set up for boiler design, it is necessary for local inspectors to approve the final details of the design on box-type header construction. Consequently with code construction there is some leeway in the type header construction dependent upon the inspector's interpretation of the design.

For a code to be workable it should not discriminate or restrict in any way new ideas in the development of equipment for the industry.

The problems of the manufacturer and the purchaser are closely related and should be resolved by the development of some means of mutual understanding, whereby the purchaser can specify a duty with the performance conditions and method of fabrication. The manufacturer in turn can submit equipment complying with the purchaser's specifications from the information received. The purchaser could then evaluate the equipment with the knowledge that all bids would conform to a minimum standard. Owing to the growth of the air-cooled industry a code should be formulated for this phase of heat-exchanger manufacturing. For a code to be workable it should be based on the agreement and requirements of the majority. Consequently it should be written by a committee and approved by the manufacturer's and purchaser's engineering departments.

Job Evaluation—A System of Salary Determination, by A. de Leon, Warren Petroleum Corporation, Tulsa, Oklahoma. 1956 ASME Petroleum Mechanical Engineering Conference paper No. **56—PET-18** (multilithographed; available to July 1, 1957).

INCONSISTENT rate relationships between jobs, resulting from a pay rate not being consistent with job difficulty, is the only major problem job evaluation will solve and unless an adequate salary-administration system is installed in conjunction with the job-evaluation study, the cure will be short-lived. A job-evaluation system will succeed only if it is installed properly and maintained adequately.

Job analysis is divided into two parts; job description, which is written and gives all operations, methods, conditions, equipment, authority, and other essential facts about a job or position, and job specifications, a list of abilities and qualifications a person must have to perform the job satisfactorily.

The point system of job evaluation is a method by which each job is rated against separate factors and a specific total of points is assigned each job. There are four major steps in constructing a point system:

1 *Selection of factors.* Factors used in the point system generally fall into four

major headings: skill, responsibility, effort, and working conditions.

2 *Definition of factors.* Probably the most important point in actually rating a job is consistency, and consistency in rating can only be gained by clear, concise, written definitions of each factor and its subdivisions

3 *Defining degrees of each factor.* Each factor must then be divided into degrees. The different degrees are to have point values assigned them.

4 *Determining relative value of factor.* The relative value of factors should not be considered equal nor assigned the same weight in measuring their relative importance to the value of a job.

5 *Rating jobs.* After a detailed analysis is made of each job, the rating committee rates or assigns a rating to a number of bench-mark jobs. When this has been completed, all jobs to be covered by the program are then rated.

There are actually two more steps to complete installation of the point plan of job evaluation. The first involves establishing grades into which the jobs are assigned in accordance with their ratings. The second is establishing the salary ranges for each grade.

And so, the problem is basically how to compare unlike jobs that are equal in worth to the company and arrive at a salary rate.

Aluminizing Aspects of Fabricated Pipe and Piping Components, by E. M. Peloubet, Arthur Tickle Engineering Works, Incorporated, Brooklyn, N. Y. 1956 ASME Petroleum Mechanical Engineering Conference paper No. **56—PET-35** (multilithographed; available to July 1, 1957).

SURFACE coatings of aluminum are being commercially applied to ferrous base, nickel base, and cobalt base metals by four processes; namely, (1) hot dipping, (2) spray metallizing, (3) calorizing, (4) the solaramic slurry process. The actual applicators of these coatings may use combinations and variations of the above processes, within the limit of certain patent rights as may be applied to the processes. The scope of this paper will contain only a discussion of aluminizing by hot dipping.

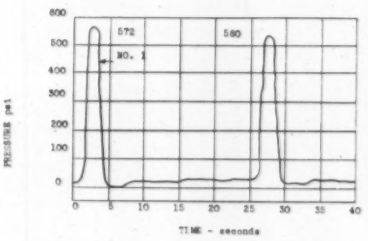
The Arthur Tickle Engineering Works has been furnishing hot-dip aluminized coatings on pipe, piping components, and vessel nozzles and internals for three years.

Hot-dip aluminized coatings are currently being commercially applied by one or a combination of two processes. The first and most economical process may be termed simply hot-dip aluminizing. For this process the requirements are a molten bath of aluminum and suitable cleaning equipment prior to immersion of the article in the molten aluminum bath. In many respects this process is very similar to hot-dip galvanizing. The second hot-dipping process involves the use of a fluxing bath prior to and following immersion in the molten aluminum. This is a patented process which is known as "Al-Dip."

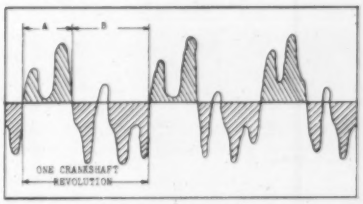
The primary considerations for obtaining a satisfactory hot-dipped aluminized coating on piping components are discussed, as are the methods of making the hot-dip aluminized coating, masking agents, inspection of the hot-dipped coatings for questionable areas, and methods of reducing air pockets to assure a satisfactory coating.

Pulsation Absorbers—Their Design and Application, by Harry M. Wyatt, Jr., Oklahoma Institute of Technology, Oklahoma A. and M. College, Stillwater, Oklahoma. 1956 Petroleum Mechanical Engineering Conference paper No. **56—PET-31** (multilithographed; available to July 1, 1957).

PRESSURE variations, commonly called pressure surges, occur in all systems transporting liquids. These pressure surges, caused by the acceleration and deceleration of the fluid column, arise from the valve actions of pumps, from water hammer due to valve closure or similar sudden restrictions, or from combination of both. The magnitude of these pressure surges is dictated by the severity of the velocity change. The figures show time-pressure recordings of some typical pressure variations. The annoying effects of pressure surge appear in many forms, such as: (1) Failure of system due to overstressing, (2) failure of system due to fatigue caused by high-magnitude high-frequency surges, (3) loss of pump efficiency, (4) dangerous vibration in series—paralleling of fluid pumps, (5) errors in correct metering caused by inertial effect of pressure surges, (6) interference of



Pressure-surge time curve for rapid valve closure on truck loading rack, Pasadena, Texas



Double acting two-cylinder 90-degree crank reciprocating pump

pump surges with bottom hole drilling devices, (7) fire hazard when handling inflammable liquid.

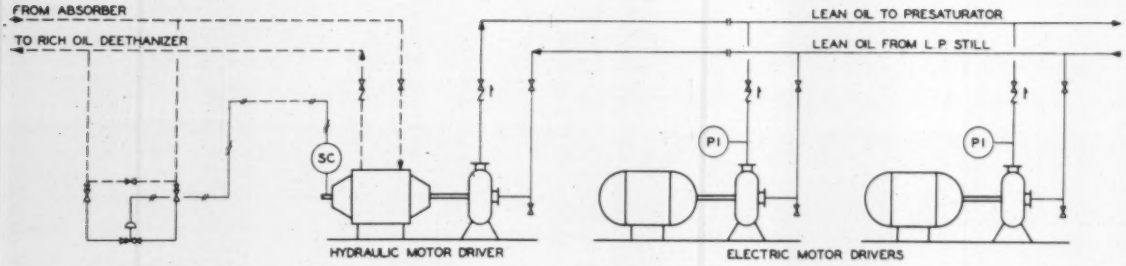
This investigation, as presented in this paper, was initiated to study the causes of pressure variations, investigate the design of surge dampening devices, compare the actual efficiency of surge removing devices, and review the recommended application of desurgers.

Apparatus for Sampling Particulate Matter in High-Pressure Gas Streams, by R. L. Solnick, Mem. ASME, The Fluor Corporation, Ltd., Whittier, California. 1956 ASME Petroleum Mechanical Engineering Conference paper No. **56—PET-16** (multilithographed; available to July 1, 1957).

THE problem of determining the quantity and size distribution of liquid and solid particulate matter suspended in a gaseous stream has plagued the engineer for many years. Under high-pressure conditions, this problem becomes particularly difficult. Since the company with which the author is associated markets a high-pressure gas cleaner, it was necessary to develop an apparatus capable of performing the foregoing function. Discussed here is the design of such a device which was built and tested, as well as the difficulties encountered during its development, and a discussion of operational procedure and suggested improvements on the original design.

Hydraulic Drives Using Rich-Oil Power Units, by B. J. Thompson, Warren Petroleum Corporation, Tulsa, Oklahoma. 1956 ASME Petroleum Mechanical Engineering Conference paper No. **56—PET-9** (multilithographed; available to July 1, 1957).

THE use of hydraulic energy as a power source dates back to early civilization. Applications of hydraulic power which are common today include water turbines to drive electrical generators, pumps, and blowers. Hydraulic-oil systems are employed for lifting devices, various aircraft applications, automotive applications, and heavy industrial equipment power source.



Schematic diagram of the centrifugal-type, hydraulic-driver, flow-controller unit run by liquid fluids under pressure

A fluid or hydraulic motor is a prime mover run by oil or other liquid fluids under pressure by taking a pressure drop through the power unit. It is well to keep in mind that any unit that can be used as a pump also may be used as a motor or hydraulic power unit by flowing a stream in the reverse direction to pumping service.

A specific and somewhat unique application of hydraulic power of current interest is to recover power available when a liquid stream is reduced in pressure. The special application is known as a "rich-oil turbine or motor." This recent development in the application of hydraulic power has occurred within the past decade. Many natural-gas-processing plants employ absorption oil at an elevated pressure to extract light hydrocarbon fractions from natural gas. Absorber operating pressures ranging from 500 to 2000 psi are common. A substantial number of the adsorption plants operate in the 700 to 800-psi range. The rich-oil stream leaving the bottom of the absorber is quite commonly reduced in pressure through a differential of 250 to 550 psi. If several hundred gallons of oil per minute are flowing through the system, a substantial horsepower loss is represented by this pressure letdown through a conventional diaphragm-operated control valve.

Studies and investigations have been conducted to determine a practical way to recover, for useful consumption, the horsepower normally wasted by the pressure-letdown step in the process.

The author has knowledge of five different makes of hydraulic power units which have been applied to the rich-oil system. Some manufacturers have applied centrifugal units while others use rotary-piston, rotor-vane, and screw-type power units.

The figure shows schematically the centrifugal unit which has operated two years employing a flow controller for output demand by the driven unit in combination with speed control mounted directly on the shaft of the hydraulic-turbine driver unit.

Efficiency will vary more with speed when using centrifugal-design units. A positive-displacement unit exhibits a smooth output-torque curve and therefore high efficiency over a wide speed and load range. The optimum efficiency is obtained from a centrifugal-design unit when it operates near its design speed and flow rate. Thus, it is apparent that the centrifugal unit is not the optimum choice for applications requiring wide variations of speed and horsepower.

It is generally recommended that any system employing hydraulic drives be thoroughly cleaned of all extraneous materials and preferably that a strainer be installed temporarily or permanently in the inlet piping to insure that foreign materials including dirt, welding slag, pipe scale, and other hard materials will not enter the hydraulic unit. This is particularly important for the close-clearance-type units.

The delivered cost of various hydraulic power units, used in rich-oil service in the past 5 years, ranges from $20 to $210 per rated horsepower.

Sufficient experience is recorded to indicate the feasibility of using rich-oil powered drivers for continuous service. Operators planning the use of hydraulic rich-oil motors will be wise to analyze each application carefully to determine the type (displacement or centrifugal) unit design best suited for the specific installation. Manufacturers of hydraulic power units can be of considerable assistance in reviewing specific service applications.

A Program for Controlling Construction Costs, by J. E. Ross, Mem. ASME, The Dow Chemical Company, Freeport, Texas. 1956 ASME Petroleum Mechanical Engineering Conference paper No. **56—PET-10** (multilithographed; available to July 1, 1957).

All contracting work done on the Texas Division of the Dow Chemical Company is done on incentive contracts, most of them straight lump sums. This paper contains a discussion of this method and the results of the contractual management whereby expenditures for construction and large maintenance projects have been controlled. Results, including apparent savings in costs and increases in efficiency, are also presented for the set of conditions, and advantages and limitations of the system are discussed.

Remote Control and Operation of Booster Stations on the Platte Pipeline System, by F. D. Marts, Platte Pipe Line Company, Kansas City, Mo. 1956 ASME Petroleum Mechanical Engineering Conference paper No. **56—PET-14** (multilithographed; available to July 1, 1957).

The Platte Pipe Line Company operates a large-diameter crude-oil line that stretches from the Byron-Garland area of Northern Wyoming 1200 miles across Wyoming, Nebraska, northeastern Kansas, and Missouri to a terminus in the Wood River, Ill., refining area. This line was conceived, designed, and constructed in 1951 and 1952. Pipe-line transportation must stay abreast of the ever-changing crude picture. Between 1951 and 1955 it was twice necessary to redesign and expand the system.

The remote-control systems discussed in this paper are presently in operation on the Platte 20-in-line segment.

The remote control and operation of completely automatic pumping stations are practical and entirely feasible. Platte's experience in this mode of operation has been of relatively short duration; however, the success it has had thus far has been of such proportion that any future station design will center, in so far as possible, around remote automatic operation. Bringing the entire remote system up from its infancy to its present operating status produced many headaches and problems, but the results were more than gratifying.

The company would not hesitate to recommend this type system for application to any new pipeline or to others wishing to improve an existing system, as they feel it can be justified fully both economically and from the standpoint of satisfactory operation.

Mechanical Design Problems Connected With Ammonia Synthesis, by C. E. Freese, Mem. ASME, The Fluor Corporation, Ltd., Los Angeles, Calif. 1956 ASME Petroleum Mechanical Engineering Conference paper No. **56—PET-1** (multilithographed; available to July 1, 1957).

AMMONIA is synthetically produced from natural gas, petroleum gases, waste gases from other processing, or other hydrocarbons. The quality of the gas used determines the process equipment required to prepare it for use in the manufacture of ammonia.

Like many other chemical processes, certain phases are patented by various companies and some details are held secret. The items outlined in this paper do not involve secret processing or patented design which would prohibit discussion. They consist primarily of the following: (1) High-pressure vessels; (2) high-pressure tubing; (3) high-pressure flange connections; (4) comments on compressors and high-pressure valves; (5) comments on liquid-air plant and equipment.

The manufacture of synthetic ammonia presents problems common to many other high-pressure processes of today. The object of this paper is to outline some of these and describe, to a limited extent, the design experience which has been obtained. Theoretical design data and derivations are left to the reader to review, if he desires, by reference to articles pertaining to thick-wall vessels and high-pressure equipment. Likewise no attempt has been made to describe and evaluate a large number of detail designs where this information is published elsewhere. Certain differences in American and European practices are noted.

ASME Transactions

for November, 1956

THE November, 1956, issue of the Transactions of the ASME (available at $1 per copy to ASME members; $1.50 to nonmembers), contains the following technical papers:

Heat-Conduction Methods in Forced-Convection Flow, by S. Levy. (54—A-142)

Effect of Vapor Velocity on Laminar and Turbulent-Film Condensation, by W. M. Rohsenow, J. H. Webber, and A. T. Ling. (54—A-145)

Heat Transfer and Temperature Distribution in Laminar-Film Condensation, by W. M. Rohsenow. (54—A-144)

The Friction Process in Metal Cutting, by Iain Finnie and M. C. Shaw. (54—A-108)

Scoring Characteristics of Thirty-Eight Different Elemental Metals in High-Speed Sliding Contact With Steel, by A. E. Roach, C. L. Goodzeit, and R. P. Hunnicutt. (54—A-61)

Frictional Characteristics and Surface Damage of Thirty-Nine Different Elemental Metals in Sliding Contact With Iron, by C. L. Goodzeit, R. P. Hunnicutt, and A. E. Roach. (54—A-53)

Closed Systems for Testing Compressors, by R. M. Johnson. (55—A-157)

The Slotted-Blade Axial-Flow Blower, by H. E. Sheets. (55—A-156)

Thermodynamic Aspects of Cavitation in Centrifugal Pumps, by H. A. Stahl and A. J. Stepanoff. (55—A-136)

Turbulence and Boundary-Layer Effects on Cavitation Inception From Gas Nuclei, by J. W. Daily and V. E. Johnson, Jr. (55—A-142)

Critical Considerations on Cavitation Limits of Centrifugal and Axial-Flow Pumps, by G. F. Wislicenus. (55—A-144)

Some Aspects of High-Suction Specific-Speed Pump Inducers, by C. C. Ross and Gordon Banerian. (55—A-124)

The Design of Axial Flow Pumps, by R. D. Bowerman. (55—A-127)

Suppression of Pump Vibrations Set Up at Starting Up—Preopening Method, by F. Numachi. (55—A-145)

Evaluation of Factors Affecting Heat Transfer in Furnaces, by Murray Greyson, G. P. Mazie, J. W. Myers, R. C. Corey, and E. G. Graf.

Fly-Ash Refiring, by F. G. Feeley, Jr. (55—A-182)

The Supercharged-and-Intercooled Free-Piston-and-Turbine Compound Engine—A Cycle Analysis, by A. L. London. (55—A-147)

The Thermodynamics of Cooled Turbines, Part I, by W. R. Hawthorne. (55—A-186)

The Thermodynamics of Cooled Turbines, Part 2, by W. R. Hawthorne. (55—A-191)

Effect of Turbine-Blade Cooling on Efficiency of a Simple Gas-Turbine Power Plant, by W. M. Rohsenow. (55—A-120)

Analysis of the Effect of Blade Cooling on Gas-Turbine Performance, by J. C. Burke, B. L. Buteau, and W. M. Rohsenow.

Test of an Experimental Coal-Burning Turbine, by D. L. Mordell and R. W. Foster-Pegg. (55—A-158)

Laminar-Free-Convection Heat Transfer From the Outer Surface of a Vertical Circular Cylinder, by E. M. Sparrow and J. L. Gregg. (55—A-25)

Combined Forced and Free-Laminar Heat Transfer in Vertical Tubes With Uniform Internal Heat Generation, by T. M. Hallman. (55—A-73)

Free-Convection Heat Transfer From a Horizontal Right Circular Cylinder to Freon 12 Near the Critical State, by D. L. Doughty and R. M. Drake, Jr. (55—A-100)

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Comments on Papers

Including Letters From Readers on Miscellaneous Subjects

Shortage of Engineers

Comment by Tom M. Gayle[1]

THE author's comments on the shortage of engineers[2] are lucid and concise and they summarize, to a great degree, the theme with which industry has been bombarding the American public. It is noteworthy that the author points out there is an absolute shortage of 50,000 engineers to fit into our peacetime economy. How are such figures calculated? I wonder if he has figures at hand to show the numbers of engineers tied up directly or indirectly with defense contracts. I am sure that the percentage will be found extremely high. This fact is often masked because so many engineers are reported as being employed by "private industry" when in reality they are working solely on prime government contracts. In grasping for the true picture in this shortage of engineers, let us take a look at the other side and see what others are saying regarding the situation.

Dr. Maynard M. Boring, President of the American Society of Engineering Education and manager of technical personnel development for the General Electric Company, has recently stated that "much hysteria" has surrounded the shortage of engineers. Addressing the N.S.P.E., Dr. Boring stated, "If we had a 10 per cent drop in our economy, we would have engineers raining out our ears." He also stated that if the 68,000 engineers which industry claims it needs were provided, they (industry) wouldn't know what to do with them.

Enoch R. Needles, President of the American Society of Civil Engineers, addressing the Rotary Club of Knoxville, Tenn., in June, stated that talk about a shortage of engineers had no basis in fact. He further stated, "In my opinion the shortage of professional civil engineers is far from being established." Mr. Needles went on to point out that the engineer has been used for personnel work, office administration, and positions of like character simply because the engineer has filled these positions most capably but not to his own greatest professional advantage.

Overexpansion in Engineering Education. These opinions are by no means new nor are they limited to the engineering profession. Over two years ago, Roger Babson, noted economist and syndicated columnist, was warning against the reckless overexpansion in the field of engineering education and about the way in which youth was being misled.

At least, if we are going to urge our young people strongly to become engineers, let us tell them the truth about the number of engineers doing nonprofessional work and also let us be sure that the high starting salaries are not misleading. Dr. Eli Ginzberg, research director of the National Manpower Council, stated in Washington, on May 17, of this year, that, "With all our screaming about the engineer shortage, very little is done to make the engineer's lot more satisfactory." Dr. Howard Meyerhoff, executive director of the Scientific Manpower Commission, stated on the same occasion that young engineers and scientists get high starting salaries but "after a few years, they find they aren't much better off than when they started." Both men warned against putting safety in "sheer numbers" of engineers.

What is needed is quality first and quantity second. Of course, anyone who advocates anything less than turning out all the engineers industry demands is sort of "unpatriotic" because "Russia is getting ahead." A man-for-man race with Russia just doesn't make sense. Dr. Ginzberg summed it up pretty well when he said, "Russia has seven times as many farmers as we have, but that doesn't mean Russia is outproducing us on food. In fact we outproduce them." The same thing applies to armed forces. Russia greatly outnumbers us, but I wouldn't say we are inferior. Here as in other fields we have concentrated on training and quality.

Technician Training. It is extremely easy for industry to cry "engineer shortage" while at the same time doing little to alleviate the situation. I have heard of dozens of companies sending out high-powered recruiting teams, but I have heard of very few companies training any great numbers of technicians so that their engineers may be freed for engineering work exclusively. Why cannot industry pool its resources and embark on an on-the-job technicians' training program, from likely material from the ranks of skilled labor or from qualified high-school graduates? This, to me, is the type of thing the Society should be advocating, rather than seeking to flood the market with engineers. The reason industry prefers to publicize the shortage and demand more college graduates is painfully simple. It is an easy matter for industry to hire "ready made" technical people from our colleges and universities and use them for everything imaginable. Such practice is good economics because the technical graduate is capable of "thinking" and as such is an asset in many fields. Unfortunately, such practice causes the type of shortage we now have.

Colin Carmichael, editor of *Machine Design*, has done a fine summing up of the situation in his editorial "How to Create a Shortage of Engineers," in the April, 1955, issue of that publication. The following quotation from that editorial is noteworthy. "Help-Wanted ads for design engineers continue to crowd the pages of our daily newspapers. Possibly mistaking a symptom for a disease, many people including much of management personnel keep crying 'shortage of engineers.' What do working engineers themselves say? Those with whom we have talked and who have written to us say that the shortage is phony. They say it could disappear overnight if the management of industry would come to grips with the facts. Dissatisfaction and restlessness prompt engineers to seek greener pastures. Thus the high volume of want ads may simply reflect the large turnover in engineering employment. High turnovers in such a specialized activity mean inefficiency. Inefficiency creates a need for more engineers than should be necessary, lending credence to the shortage theory."

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[1] Development Engineer, Instrument Department, Oak Ridge National Laboratory, Oak Ridge, Tenn. Assoc. Mem. ASME.

[2] "You and the Engineering Shortage," by Joseph W. Barker, MECHANICAL ENGINEERING, June, 1956, vol. 78, pp. 506–508.

The article goes on to point out that the experienced engineers' real income today is less than it was in 1940. Mr. Carmichael quotes some authoritative and convincing figures to prove the point. It would be most interesting today to see how engineers rather than how management feels about the shortage. Is there a shortage of engineers or is there just a shortage of "ready made technical helpers" for which the engineer is being extensively used?

As for myself, I prefer to encourage at least some of the young people I know to undertake the study of medicine or some other field, where a true shortage of professional people is rather obvious.

Properties of Steam

Comment by P. H. Knowlton, Jr.[3]

EARLY in their report[4] the authors clearly stated their purpose—to provide a table of steam properties more inclusive than the Keenan and Keyes Table (authors' reference 4) for interim use by the steam-power industry. The question as to whether such a table should be prepared was discussed by the Technical Committee of the ASME Research Committee on Properties of Steam. The Technical Committee concluded that whereas such a table might be useful, its preparation lay outside the proper scope of the Technical Committee, whose charter calls for the final production of an authoritative table based on new data to be obtained from experimental work now going on in this country and abroad.

This seems a logical conclusion. The action of the Power Division Committee follows also logically from the desire of the industry to have something to work with in the meantime.

In furtherance of the new work on steam properties which will result in a new authoritative table, an International Steam Tables Conference was held in London in July, at which the ASME program was discussed as well as all of the other important work in other programs. It is planned that a report on this Conference, and its correlation with our own ASME program, will be made this fall to the Society, and to the sponsors of the ASME Steam Properties Research Programs whose generous financial support has made this important work possible.

Comment by A. C. Holmes[5]

The authors and members of the task force are to be complimented for their ingenuity and effort in providing "An Interim Steam Table" for the high-pressure and high-temperature properties of steam above that now available in published tables. Though the data presented do not represent an authoritative table backed by experimental data, they do provide a standard of consistent information based on reasonable extrapolation of available tables.

The "Interim Table" will provide the ever-advancing steam-power utility industry with consistent and acceptable data for the advance studies and the design of power plants and their components until more accurate data are available. These tables will provide the common base necessary for making economic evaluations of steam-power-plant components under competitive situations.

Comment by Joseph H. Keenan[6]

This is a useful and satisfactory extension of the present steam tables. The authors are the first to point out the double maximum in the specific heats along a constant-pressure curve of the tables prepared by the United Aircraft Corporation. The complexity of the UAC formulation had concealed this characteristic, although it becomes evident to anyone who takes the trouble to calculate second differences from the table.

It appears that the authors have devised supercritical isopiestics which show only a single point of inflection for enthalpy plotted against temperature and for volume plotted against temperature. It must be remembered, however, that the highest temperature in the Amagat observations was 388 F and that the lowest temperature for which the authors accepted the UAC values was 959 F. This is a large temperature gap to bridge with the meager aids employed. Some new Russian observations of specific volume and specific heat are available to about 7000 psia. The specific-heat observations are in fairly good agreement with the curves of Fig. 2. Have the authors compared their tabulated values with the values observed by the Russian experimenters? Fortunately, such errors as may have resulted from the method of the authors will have only small effect in the calculation of the usual power-plant cycles.

Comment by C. C. Franck, Sr.[7]

The writer is privileged for this opportunity to express the appreciation of the steam-turbine industry for this excellent paper.

The analytical skill and thoroughness shown by the authors is to be highly commended. Starting with meager tangible information, the authors have prepared and presented a set of data which should serve the industry well until the results of the ASME steam properties research are available.

The preparation of this information attests to the tremendous potentialities of the modern electronic computer. Projecting back to the period of preparation for our existing properties of steam, one must marvel at the speed with which the authors accumulated and presented information with the assistance of these computers. It is reassuring to know that once the fundamental research on the properties of steam at higher pressures and temperature has been completed, the aid of these modern conveniences will reduce the time which will be required to present the information in usable form.

Authors' Closure

The authors wish to express their thanks for the encouraging comments and guidance of all the discussers. The comment by P. H. Knowlton, Jr., provided the very helpful background information defining the purpose of the paper.

The discovery of the double inflection in the United Aircraft Corporation specific heat curves so kindly credited to the authors by Professor Keenan was previously pointed out in the Battelle report[8] which used Kennedy's basic data.

Professor Keenan's question regarding comparison with the recent Russian data[9]

[3] Chairman, Technical Committee of the ASME Research Committee on Properties of Steam; Advanced Design Engineering, Large Steam Turbine-Generator Engineering Section, Turbine Division, General Electric Company, Schenectady, N. Y. Fellow ASME.

[4] "Properties of Steam at High Pressures—An Interim Steam Table," by R. C. Spencer, C. A. Meyer, and R. D. Baird, MECHANICAL ENGINEERING, July, 1956, vol. 78, pp. 615–619.

[5] Engineer in Charge, Steam Design Division, Steam Turbine Department, Allis Chalmers Manufacturing Company, Milwaukee, Wis. Mem. ASME.

[6] Professor of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, Mass. Fellow ASME.

[7] Consulting Engineer, Steam Division, Westinghouse Electric Corporation, Philadelphia, Pa.

[8] "Empirical Evaluation of the Properties of Steam at Elevated Temperatures and Pressures," by A. W. Lemmon, et al., Battelle Memorial Institute Report No. BMI 858, p. 20, August, 1953.

[9] "Experimental Determination of the Specific Volumes of Steam From 92 to 524 Absolute Atmospheres and From 430 to 600 C," by W. A. Kirillin and L. L. Rumjansev, Elektritscheskije Sstanzii 21, 8, 1950, abstracted in Zeitschriften Schau 4, 94, 1952.

is answered by stating that the United Aircraft report, reference (2) of the paper, includes a comparison curve Fig. 3 showing good agreement between the Keenan and Keyes, Kennedy, and the Russian Volume data to 7000 psi and between 430 and 600 C.

R. C. Spencer.[10]
C. A. Meyer.[11]
R. D. Baird.[12]

Drying Sawdust

Comment by C. W. Gordon[13]

We have read with great interest the paper on suspension-drying of sawdust[14] and wish to congratulate the authors on making available some very interesting test information.

We have been interested in this over-all problem for many years as it relates to the drying of wood waste and bark. As a matter of interest, the processes reported in references (2) and (3) of the authors' Bibliography are based on developments of the writer's company.

Much has been written and said concerning the advantages and disadvantages of predrying of wood waste and bark prior to burning for steam generation. Mathematical treatment of the subject will show a distinct gain in thermal efficiency when predrying is practiced. From a practical point of view, we have approached the matter of predrying by using very high-temperature gases extracted directly from the furnace and of the order of 1500 to 1600 F. We have found that drying equipment based on using exhaust gases from the steam-generating equipment becomes so large as to be prohibitive in first cost.

Even though furnace gases are used for the drying operation, the increase in thermal efficiency can be fully realized as can be shown by the simplest of heat balances. For example, in one study which we prepared, relating particularly to wet bark, the following results were obtained:

Heat value of bark....8500 Btu per lb of dry solids
Heat available for steam generation expressed in Btu per lb of drying solids:
No predrying.....3499
With predrying:
Unpressed bark at 66.7 per cent moisture.....4010
Pressed bark at 60 per cent moisture...4646

In the foregoing tabulation predrying with unpressed bark results in a 14.7 per cent gain in steam generation and with pressed bark 32.9 per cent.

In general, it has been our experience that air-stream drying as described in this paper can be made much more effective by the installation of a cage mill in the system, which results in greatly increased turbulence and, therefore, a considerably increased moisture reduction. In case it is desirable to reduce particle size further, the cage mill may be equipped with fan blades and run at sufficiently high speed to produce all the fan power necessary. This design was used effectively at the Great Lakes Paper Company installation.

Comment by W. S. Landers[15]

This paper presents some interesting and useful information on applying suspension-drying to sawdust. It meets the authors' objective of presenting fundamental design data. However, there are other factors which need to be evaluated. It would be helpful to know the pressure drops involved in the experimental work conducted to date, since this frequently influences blower selection in the design of practical suspension driers. It is likely that the pressure drops are quite low in case of sawdust, but it is of significance in plant design. The composition of the gases developed would be of interest because of safety considerations. The experimental unit described in this paper is operated with products of combustion developed from propane-air mixtures, and the temperature of the hot gases entering the drier column is apparently controlled by supplying excess air. There is some danger associated with this scheme because of the high oxygen content of the gases and the possibility of a fire or explosion in the separating system.

The Bureau of Mines in Denver, Colo., has demonstrated the general feasibility of drying sawdust in suspension in the Parry drier. However, our work was not extensive enough to develop the excellent data presented in this paper. Our general experience in drying coal has been that the dust content of the exhaust gases from the separating system increases as the temperature of the exhaust gases increases, generally with a marked increase in dust content when the temperature rises from about 275 to 325 F.

This effect may not be encountered with sawdust because it does not tend to degrade as much during drying as a granular material. It is interesting to note that when drying pine-wood sawdust, we noted very little shrinkage or change in average size of the particles, whereas in the case of lignite or high-moisture coal the average size of the dried product was frequently less than half the average size of the raw-feed material. These results are shown in Bureau of Mines Report of Investigation 4954.

Authors' Closure

The comments of Mr. Gordon are welcomed by the authors. In reference to his last paragraph, a device such as a cage mill would be advantageous in increasing turbulence. However, such an arrangement would cause increased maintenance by introducing rotating machinery into the hot gas. If the cage mill were modified to serve also as the fan, a larger volume of hot gas must be handled by the fan. Increased gas volume requires a larger fan and greater fan power.

Therefore, the advantage of increased turbulence must be weighed against more maintenance, a larger fan, and increased power consumption.

Mr. Landers' remarks are appreciated, and his question concerning pressure drop is pertinent. To give an indication of the magnitude of the pressure drop in the test drier, at an air rate of 4180 lb per sq ft per hr, 1000 F initial gas temperature, and a sawdust-air ratio of 1:1, the static pressure was about $2^1/_2$ in. of water at the point where sawdust entered the gas stream. The drying gas did have a relatively high oxygen content as pointed out by Mr. Landers. However, sawdust contains relatively few fine dust particles in comparison with coal or lignite. In drying sawdust no fires or explosions were experienced in the test drier. If material such as sander dust or wood flour were dried, the explosion hazard should not be ignored.

S. E. Corder.[16]
C. O. Morris.[17]
G. H. Atherton.[16]

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[13] General Manager, Raymond Division, Combustion Engineering, Inc., Chicago, Ill. Mem. ASME.

[14] "Suspension-Drying of Sawdust," by S. E. Corder, C. O. Morris, and G. H. Atherton, Mechanical Engineering, July, 1956, vol. 78, pp. 627–629.

[15] Supervising Fuel Technologist, Branch of Coal Technology, Bureau of Mines, Region III, Denver, Colo.

[16] Mechanical Engineer, Oregon Forest Products Laboratory, Corvallis, Ore. Assoc. Mem. ASME.

[17] Mechanical Engineer, now with Boeing Airplane Company, Seattle, Wash.

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And Notes on Books Received in Engineering Societies Library

Lubrication for Engineers

THEORY AND PRACTICE OF LUBRICATION FOR ENGINEERS. By Dudley D. Fuller. John Wiley and Sons, Inc., New York, N. Y., and Chapman and Hall, Ltd., London, England, 1956. Cloth, $5^3/_4 \times 9$ in., indexes, figs., tables, references, examples, xiii and 432 pp., $10.50.

Reviewed by S. J. Needs[1]

IT is only during recent years that textbooks treating exclusively the general subject of bearings and lubrication have begun to make their appearance. This book by Dudley Fuller is a welcome addition to the slowly growing list. Most books and papers on bearings are not easily read due largely to the complexity of the mathematics involved. While not minimizing the analytical difficulties of the basic theory, Professor Fuller plays them down rather than up, thus bringing the reader to practical solutions without mathematical exhaustion. The book reaches into the fields of both lubricants and bearings and considering the amount of ground covered is remarkably easy to read. It will serve equally well as a text for the student and a reference book for both the general engineer and lubrication specialist.

Since viscosity is the most important property of oils from the lubrication point of view, the book properly starts by devoting chapters 1 and 2 to the fundamentals of oil flow and viscosity with its variables and methods of measurement. A chapter on hydrostatic lubrication gives both theoretical and practical information on the growing practice of reducing starting friction in heavily loaded thrust and journal bearings by separating the bearing surfaces with oil under high pressure prior to the start.

There is a chapter on hydrostatic squeeze films and, of course, hydrodynamic lubrication of thrust and journal bearings is discussed in considerable detail with particular emphasis on the latter. Methods of evaluating friction, load-carrying capacity, power loss, and bearing-temperature rise are given. Chapters on air-lubricated bearings, dry friction, boundary friction, and bearing materials round out this well-planned and well-written book. It is illustrated by charts, tables, drawings, and photographs and each chapter is followed by a list of references for the more curious mind.

[1] Service Manager, Kingsbury Machine Works, Inc., Philadelphia, Pa. Mem. ASME.

Books Received in Library

NOUVELLE MÉTHODE APPROCHÉE DE CALCUL DES COUCHES LIMITES LAMINAIRE ET TURBULENTE EN ECOULEMENT COMPRESSIBLE. By Alfred Walz. Publications Scientifiques et Techniques No. 309. 1956, Ministere de L'Air, Paris. 87 p., $7^1/_4 \times 10^5/_8$ in., paper. Francs 950. A detailed exposition of a new approximate method for the calculation of laminar and turbulent boundary layers in compressible flow. Graphical representations as well as the mathematical analyses are given.

NUCLEAR FUELS. By David H. Gurinsky and G. J. Dienes. (The Geneva Series on the Peaceful Uses of Atomic Energy.) 1956, D. Van Nostrand Company, Inc., Princeton, N. J. 364 p., $6 \times 9^1/_4$ in., bound. $7.50. This is one of a series of six volumes made up of edited and integrated selections from papers delivered at the International Conference on the Peaceful Uses of Atomic Energy. The present volume, intended as an introduction to the subject, gives basic information on the metallurgy of uranium and thorium, the problem of radiation, and specific fuel systems using solid and fluid fuels.

NUMERICAL ANALYSIS. Proceedings of Symposiums in Applied Mathematics of the American Mathematical Society, volume 6. 1956, McGraw-Hill Book Company, New York 36, N. Y. 303 p., $6^3/_4 \times 10^1/_8$ in., bound. $9.75. Among the topics covered in the 19 papers comprising this volume are the theory of dynamic programming; boundary-valve problems; combinatorial problems; shock configuration in Mach reflection; applications of gradient methods; approximations in numerical analysis; the method of steepest descent; and the solution of linear systems by iteration.

SYMPOSIUM ON ATMOSPHERIC CORROSION OF NONFERROUS METALS. (Special Technical Publication No. 175.) Published, 1956, by the American Society for Testing Materials, Philadelphia, Pa. 158 p., 6×9 in., paper. $2.75. This symposium contains a report on a 20-year testing program conducted by the ASTM, and nine papers based, mainly, on the results of the tests. The materials covered are copper and copper alloys, aluminum, magnesium coupled to other metals, rolled zinc, lead, tin, and nickel.

THE PETROLEUM REFINERY ENGINEER'S HANDBOOK. By J. F. Strachan. 1956, Philosophical Library, Inc., New York, N. Y. 168 p., $7^3/_8 \times 10$ in., bound. $15. Despite its inclusive title this is a manual for those responsible for the inspection and safety of refinery equipment. The first two chapters deal with the organization, personnel, and records of the inspection department and with inspection procedures for the various refinery processes. The remaining three chapters are concerned with corrosion and protective measures, formulas for calculating the strength of pipes and vessels, and general safety measures.

PETROLEUM REFINING WITH CHEMICALS. By Vladimir A. Kalichevsky and Kenneth A. Kobe. Published, 1956, by Elsevier Publishing Company. Available in the United States from D. Van Nostrand Company, Inc., Princeton, N. J. 780 p., $5^3/_4 \times 9$ in., bound. $14.50. This volume is a systematic treatise on the use of chemicals and solvents in the preparation of liquid-petroleum products and waxes. Crude-oil emulsions, petroleum composition, and testing methods are dealt with in introductory chapters, and the next five chapters cover refining with acids, alkalies, adsorbents, desulfurizing agents, and solvents. One chapter is devoted to deasphalting and dewaxing, and the last two chapters describe the use of additives in nonviscous petroleum fractions and in lubricating oils. Over 8000 literature and patent references are included in the bibliographies following each chapter.

PRACTICAL SOLUTION OF TORSIONAL VIBRATION PROBLEMS. Volume 1. Frequency Calculations. By W. Ker Wilson. Third Edition, 1956. John Wiley and Sons, Inc., New York, N. Y. 704 p., $5^1/_2 \times 8^3/_4$ in., bound. $16. This is a comprehensive treatment of principles and computational details, presented in a form suitable for everyday reference. The first volume covers simple and geared systems; coupled torsional and flexural vibrations in engine systems; the effective inertia method for determining natural frequencies; equivalent masses; and equivalent shafts. The volume also includes a history of the subject, new in this edition, and a bibliography.

PRINCIPLES AND TECHNIQUES OF APPLIED MATHEMATICS. By Bernard Friedman. 1956, John Wiley and Sons, Inc., New York, N. Y. 315 p., $5^7/_8 \times 9^1/_4$ in., bound. $8. An analysis of the methods developed in theoretical studies which can be used to systematize the solution of problems likely to be met by applied mathematicians, physicists, and engineers. In addition to providing a thorough grounding in linear spaces, spectral theory of operators, Green's functions, eigenvalue problems, and partial differential equations, the book demonstrates that logical analysis of a problem leads to the proper method for its solution.

PROCEEDINGS OF THE CONFERENCE ON FOUNDRY VENTILATION AND DUST CONTROL. HARROGATE, 1955. 1956, The British Cast Iron Research Association, Alvechurch, Birmingham, England. 257 p., $7^1/_4 \times 9^5/_8$ in., bound. $10. Sixteen technical papers deal-

ing with problems and practices in British foundries. The papers cover methods for the collection of dust, exhaust systems, the reduction of dust by the core-assembly method of molding, cleaning and maintenance, and related subjects. One of the papers is an extended account of research carried out by the Association on the formation and raising of dust, the behavior of airborne particles, and the influence on dust movement of thermal currents caused by hot castings.

PROGRESS IN NUCLEAR ENERGY. Series 1—Physics and Mathematics, volume 1. Edited by R. A. Charpie and others. 1956, McGraw-Hill Book Company, Inc., New York, N. Y. 398 p., 6 × 9¼ in., bound. $12. This volume contains critical summaries of data on fission physics made available at the International Conference on the Peaceful Uses of Atomic Energy. Of the 12 papers included, four deal with the following subjects in basic reactor physics: homogeneous critical assemblies; zero-energy studies on fast reactors; heterogeneous methods of reactor calculations; and theory and experiment of highly enriched intermediate and thermal assemblies. Other papers deal with neutron scattering and absorption, properties of fissionable materials under neutron bombardment, and delayed neutrons.

RESIDUAL WELDING STRESSES. By R. Gunnert. 1955, Almqvist and Wiksell, Stockholm, Sweden. 135 p., 6½ × 9½ in., paper. $4. Available in the United States from Gregory Lounz, 11 East 45th Street, New York 17, N. Y. The first part of this book describes a method for measuring stresses using a tensometer developed by the author. In the latter part of the book the method is used in a study of the intensity, distribution, relief, and significance of residual stresses, mainly in large carbon-steel plates.

SCHEDULING OF PETROLEUM REFINERY OPERATIONS. By Alan S. Manne. 1956, Harvard University Press, Cambridge, Mass. 185 p., 5½ × 8½ in., bound. $5. In this study, intended for petroleum engineers and economists, graphical methods, calculus, linear programming, and several types of nonlinear programming are used in the analysis of representative scheduling problems. The operations discussed are the allocation of crude oils to refineries at different locations; naphtha reforming; gasoline blending; and scheduling for a small plant in which cracking, recycling, and blending are integrated. The book also includes a brief review of conventional refinery economic analysis.

SIGNIFICANCE OF ASTM TESTS FOR PETROLEUM PRODUCTS. (Special Technical Publication No. 7-B.) Published, 1956, by the American Society for Testing Materials, Philadelphia, Pa. 115 p., 6 × 9 in., paper. $2.50. Brief, general discussions of the significance of the various tests and of their applications to specific petroleum products, including lubricants and crude petroleum. The discussions cover sampling, volume measurement and calculation, volatility, combustion, oxidation characteristics, flow characteristics, corrosion, chemical tests, analysis for hydrocarbon types, and butadiene analysis.

SODIUM, ITS MANUFACTURE, PROPERTIES, AND USES. By Marshall Sittig. (A.C.S. Monograph Series 133.) 1956, Reinhold Publishing Company, New York, N. Y. 529 p., 6 × 9¼ in., bound. $12.50. A discussion of the more important aspects of metallic sodium, combined with a comprehensive critical summary of the literature. The monograph treats recovery from alloys, as well as manufacture by thermochemical reduction and electrolysis, and it includes chapters on solubility and alloy formation; inorganic and organic reactions; and safe-handling techniques. The uses discussed are sodium as a heat-transfer medium, as an electrical conductor, as a physical agent in metallurgy, and miscellaneous physical property uses. The numerous references cited in the text are listed after each chapter.

STRUCTURE OF TURBULENT SHEAR FLOW. By A. A. Townsend. 1956, Cambridge University Press, New York, N. Y. 315 p., 5⅜ × 8⅜ in., bound. $7.50. This is an attempt to develop a consistent view of the nature of turbulent flow by considering the properties of simple forms of turbulent flow, and to apply this view to the analysis of the more common types of turbulent shear flow. The analysis covers jet, wake, and boundary-layer flow as well as flow in pipes and channels and shear flow between rotating cylinders. A bibliography is included.

SURGES ON TRANSMISSION SYSTEMS. By Shigenori Hayashi. First Edition, 1955. Denki-Shoin, Inc., Kyoto, Japan. Available in the United States from the Charles E. Tuttle Company, Rutland, Vt. 355 p., 7⅛ × 10¼ in., bound. $12. This new work brings together in compact and available form the modern mathematical theories of traveling-wave phenomena in electric transmission systems. Particular attention is paid to specialized aspects of the field, and the major part of the book is devoted to a new analytical method devised by the author for dealing with traveling waves on multiconductor systems. Rigorously presented, the method makes possible the solution of certain complex problems both in laboratory research and in practical operation.

SYMPOSIUM ON METALLIC MATERIALS FOR SERVICE AT TEMPERATURES ABOVE 1600 F. (ASTM Special Technical Publication No. 174.) Published, 1956, by the American Society for Testing Materials, Philadelphia, Pa. 193 p., 6 × 9 in., paper. $3.50. The fourteen papers included deal with the properties, testing, and applications of a variety of materials: nimonic alloys, Inconel 700, molybdenum alloys, cermets, carbides, chromium-nickel alloys, zirconium coatings, etc. References are listed following most of the papers.

Library Services

ENGINEERING Societies Library books may be borrowed by mail by ASME Members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any items in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

ASME Boiler and Pressure Vessel Code

Interpretations

THE Boiler and Pressure Vessel Committee meets regularly to consider "Cases" where users have found difficulty in interpreting the Code. These pass through the following procedure: (1) Inquiries are submitted by letter to the Secretary of the Boiler and Pressure Vessel Committee, ASME, 29 West 39th Street, New York 18, N. Y.; (2) Copies are distributed to Committee members for study; (3) At the next Committee meeting interpretations are formulated to be submitted to the ASME Board on Codes and Standards, authorized by the Council of the Society to pass upon them; (4) They are submitted to the Board for action; (5) Those which are approved are sent to the inquirers and are published in MECHANICAL ENGINEERING.

(The following Case Interpretations were formulated at the Committee meeting Sept. 14, 1956, and approved by the Board on Oct. 31, 1956.)

Annulment of Cases

The following case is annulled:

CASE NO.	REASON FOR ANNULMENT
1120	Stress values now included in Tables P-7 and UCS-23.

Case No. 1173-2

(Reopened) (Special Ruling)

In the Reply, Par. (5), add the words "in tension" after "values."

Add a new paragraph in the Reply, just before the Non-Mandatory Appendix, reading as follows:

(10) Nickel-molybdenum wrought material may be used for the construction

of vessels under external pressure under the rules applying to nonferrous materials.

(a) The required thickness of shells and heads, and the required moment of inertia for stiffening rings shall be determined from the chart in Fig. UNF-28.15.

Case No. 1194-1

(Reopened) (Special Ruling)

In the Reply, Par. (2), add the words "in tension" after "values."

Add a new paragraph in the Reply, reading as follows:

(8) Nickel - chromium - molybdenum wrought material may be used for the construction of vessels under external pressure under the Code rules applying to nonferrous materials.

(a) The required thickness of shells and heads, and the required moment of inertia for stiffening rings, shall be determined from the chart in Fig. UNF-28.16.

(Copies of these charts may be obtained on request from the Secretary of the ASME Boiler and Pressure Vessel Committee, 29 West 39th St., New York, N. Y.)

Case No. 1226-1

(Reopened) (Special Ruling)

In the Reply, revise Par. (4) to read:

(4) The thickness of the shell and head plate shall not exceed that for which stress-relieving is required in accordance with Par. UCS-56, except that for materials listed under group P-Number 1 in Table UCS-23, stress-relieving is not required in thicknesses over $1^1/_4$ in., and up to $1^1/_2$ in., inclusive, provided a preheat of 200 F is used during welding.

Case No. 1228

(Special Ruling)

Inquiry: In a two-stage construction of a containment vessel built under Case No. 1226 for a nuclear reactor, will the vessel be acceptable if during the pneumatic test certain of the welds in the lower part of the vessel are not available for inspection because of concrete shielding or concrete supports placed on inside and outside of the vessel after construction of the lower part?

Reply: It is the opinion of the Committee that containment vessels built under Case No. 1226 for nuclear reactors will meet the intent of the Code when erected in two stages, provided:

(1) All inaccessible welds are double-butt welded, radiographed, and fully inspected and tested for leak tightness using a gas medium such as halide leak detector test prior to being covered.

(2) All other requirements of the Code are met including a pneumatic test of the completed vessel.

(3) Inspection of welded joints in the lower part of the vessel during the pneumatic test will be waived where such joints are covered by concrete during the construction of the vessel, provided there are no openings or penetrations of that part of the vessel covered by concrete.

Proposed Revisions and Addenda to Boiler and Pressure Vessel Code . . .

As NEED arises, the Boiler and Pressure Vessel Committee entertains suggestions for revising its Code. Revisions approved by the Committee are published here as proposed addenda to the Code to invite criticism. If and as finally approved by the ASME Board on Codes and Standards, and formally adopted by the Council, they are printed in the annual addenda supplements to the Code. Triennially the addenda are incorporated into a new edition of the Code.

In the following the paragraph numbers indicate where the proposed revisions would apply in the various sections of the Code.

Comments should be addressed to the Secretary of the Boiler and Pressure Vessel Committee, ASME, 29 West 39th Street, New York 18, N. Y.

Power Boilers, 1956

PAR. P-268(h)(2)(e) Add the following to the last sentence of (e):

. . . similar to those illustrated in Figs. P-36 (q-1) and (q-2).

PAR. P-340(c) Change present paragraph (c) to (d) and present (d) to (e), and substitute the following for paragraph (c):

(c) In order to minimize the loss by leakage of material through the safety valve, a rupture disk may be installed between the safety valve and the vaporizer provided the following requirements are met:

(1) The cross-sectional area of the connection to a vaporizer shall be not less than the required relief area of the rupture disk.

(2) Every rupture disk shall have a specified bursting pressure at a specified temperature, shall be marked with a lot number, and shall be guaranteed by its manufacturer to burst within 5 per cent (plus or minus) of its specified bursting pressure.

(3) The specified bursting pressure at the coincident operating temperature shall be determined by bursting two or more specimens from a lot of the same material and of the same size as those to be used. The tests shall be made in a holder of the same form and pressure area dimensions as that with which the disk is to be used.

(4) A rupture disk may be installed between a safety valve and the vaporizer provided:

(a) The maximum pressure of the range for which the disk is designed to rupture does not exceed the opening pressure for which the safety valve is set.

(b) The opening provided through the rupture disk, after breakage, is sufficient to permit a flow equal to the capacity of the attached valve and there is no chance of interference with the proper functioning of the valve; but in no case shall this area be less than the inlet area of the valve.

(c) The connection between the rupture disk and the valve is so arranged as to form a pocket in which any detached fragment of the disk will be retained, and this space is provided with a pressure gage, try cock, or free vent to indicate whether the rupture disk has leaked or burst.[1]

PARS. A-95-101 Delete and substitute the following as new Par. A-95.

A-95 *Materials Not Fully Identified* Any plate material or tubular product not completely identified with a Code-approved specification shall be accepted as satisfying the requirements of a specification to be designated from among those given in Section II provided that it satisfies the conditions given in either (a) or (b) below.

(a) Each piece is shown to have chemical requirements and physical properties within the permissible range of the designated specification in Section II by an authentic test record and by marking identifying it with that record. When the designated specification requires other tests or more restrictive tests than those of the specification covered by the authentic test record, the material shall be subjected to sufficient additional tests to satisfy the inspector that it complies with the designated specification.

(b) Each piece is tested as follows to

[1] Users are warned that a rupture disk will not burst at its designed pressure if back pressure builds up in the space between the disk and the safety valve which will occur should leakage develop in the rupture disk due to corrosion or other cause.

show that it complies with the chemical requirements and physical properties of the designated specification in Section II.

(1) *Plate* The chemical check analyses and physical tests of plates shall be made as required in the designated specification with the following modifications. The carbon and manganese contents shall be determined in all check analyses. The inspector shall decide whether these contents are acceptable when the designated specification does not specify carbon and manganese limits. When the direction of rolling is not definitely known, two tension specimens shall be taken at right angles to each other from a corner of each plate, and two bend specimens shall be taken from the middle of adjacent sides of each plate. One tension specimen and both bend specimens shall meet the specification requirements.

(2) *Tubes and Pipe* Each length of tube or pipe shall be subjected to a chemical check analysis and sufficient physical tests to satisfy the inspector that all the material is identified with a given heat or heat-treatment lot, and that the material complies with the chemical and physical requirements of the designated specification. Material specified as suitable for welding, cold-bending, close coiling, and similar operations shall be given sufficient check tests to satisfy the inspector that it is suitable for the fabrication procedure to be used.

(c) When the identity of the material with the designated specification has been established in accordance with (a) or (b), each piece of material (except as alternatively provided in the specification for tubes or pipe) shall be marked to the satisfaction of the inspector by the manufacturer or the testing agency, with a marking giving the designated specification number and grade or type and a serial S-number, identifying the particular lot of material. A suitable report, clearly marked as being a "Report on Tests of Non-Identified Material," shall be furnished, properly filled out and certified by the manufacturer or testing agency, and this report when approved by the inspector shall constitute authority to use the material as provided in the Code for the designated specification.

Material Specifications, 1956

The Boiler and Pressure Vessel Committee has adopted the revisions made by ASTM for inclusion in the following specifications with the exceptions as noted:

Ferritic Castings & Forgings

SA-48-56, Revisions applying only to Classes 20 to 40, incl.
SA-193-56T
SA-194-56T
SA-216-56T
SA-217-55
SA-261-56
SA-278-56
SA-320-56T
SA-351-52T
SA-352-55T
SA-395-56T

Ferritic Tubular Products

SA-83-56T
SA-178-56T
SA-179-56T
SA-199-56T
SA-213-56T
SA-214-56T
SA-226-56T
SA-334-55T

Nonferrous Materials

SB-111-56
SB-178-56T (New revisions approved only for those alloys approved for Code use.)
SB-211-56T (Approved for GS11A-T6, GS42A-T4, and GS41A-T6 only.)
SB-234-56T (Approved for M1A, Clad M1A, and GS11A only.)
SB-273-56T (Approved for CG42A and GS11A only.)
SB-274-56T (Approved for GS11A, GS10A, M1A, and Clad M1A only. In addition, delete from the revision the paragraph referring to Table 1 as it applies only to a new alloy which has not been adopted for Code use.)

Low-Pressure Heating Boilers, 1956

PAR. H-38(a) Revise the second sentence to read:

Feedwater shall not be introduced through the openings or connections used for the relief valve, water column, or the water gage glass.

PAR. H-44(g) Delete present Par. H-44(g) and substitute the following as new Par. H-44(g):

H-44(g) Relief valve capacity for each boiler shall be such that with the fuel-burning equipment installed, pressure cannot rise more than 20 per cent above the highest maximum allowable working pressure for pressures up to and including 30 psi and 10 per cent for pressures over 30 psi.

PAR. H-91 Revise the second sentence to read:

Feedwater shall not be introduced through the openings or connections used for the relief valve, water column, or the water gage glass.

PAR. H-97(g) Delete present Par. H-97(g) and substitute the following as new Par. H-97(g):

H-97(g) Relief valve capacity for each boiler shall be such that with the fuel-burning equipment installed, pressure cannot rise more than 20 per cent above the highest maximum allowable working pressure for pressures up to and including 30 psi and 10 per cent for pressures over 30 psi.

Unfired Pressure Vessels, 1956

PAR. UG-47(g) Revise to read:

(g) The maximum pitch shall be $8\frac{1}{2}$ in., except that for welded-in staybolts the pitch may be greater provided it does not exceed 15 times the diameter of the staybolt.

PAR. UW-19(a)(2) Delete and substitute the following:

(2) The required thickness of the plate shall not exceed $\frac{3}{4}$ in.

PAR. UW-19(b)(2) Revise to read:

(2) The required thickness of the plate does not exceed $\frac{1}{2}$ in.

FIG. UW-19.1 Revise as shown in the accompanying figure.

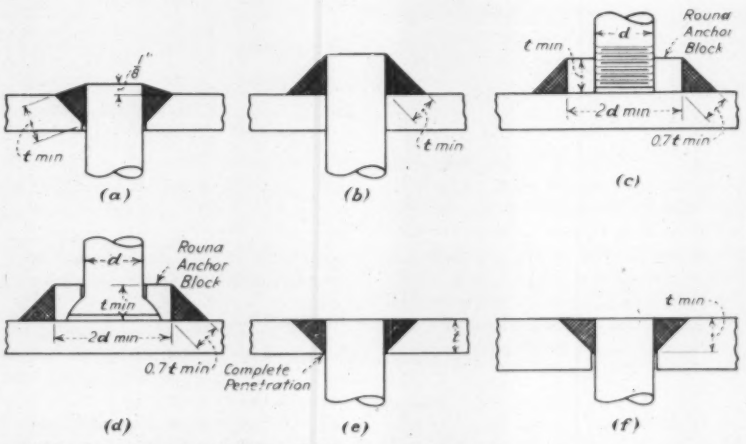


Fig. UW 19.1 Typical forms of welded staybolts

Roundup

Of Current Engineering Events, News, and Comment

E. S. Newman, *News Editor*

"Standards Are Everybody's Business" Keynotes Seventh National Conference on Standards Program Held in New York City

F. S. Blackall, jr., presented the ASA Howard Coonley Gold Medal for his service through voluntary standards

With "Standards Are Everybody's Business" as a keynote, the Seventh National Conference on Standards was held October 22–24, at the Roosevelt Hotel, New York, N. Y. Eight technical sessions were scheduled along with the Annual Award Luncheon at which the presentation of the Standards Medal and the Howard Coonley Medal took place.

Technical Program

The conferees heard H. Thomas Hallowell, Jr., president, American Standards Association, and president, Standard Pressed Steel Company, deliver the keynote address Monday morning, October 22.

"More and more people," he said, "understand that standards bring added safety in our daily living and working; that they improve efficiency; that they reduce the wear and tear on the human spirit; and that they are the means for competition on the basis of quality and performance."

He cited the role of the American Standards Association in our national progress by describing it as a comprehensive national forum where all men can meet when their standards problems become the concern of a number of different industry, professional, government, and consumer groups.

Mr. Hallowell reviewed the growth of the voluntary standards movement through World Wars I and II as well as the Korean conflict and then added: "What must concern us today is the possibility that a stop in shooting wars may cause a lull in development of national standards, simply because the need for such standards seems less urgent."

Frank P. Tisch, Mem. ASME, Aviation

F. S. Blackall, jr., *left,* past-president and Fellow ASME, president and treasurer, Taft-Peirce Manufacturing Company, Woonsocket, R. I., receives the Howard Coonley Medal from H. Thomas Hallowell, Jr., *right,* president of the American Standards Association and president, Standard Pressed Steel Company. The presentation of the gold medal was made October 24 at the annual award luncheon of the Seventh National Conference on Standards. The luncheon closed the three-day meeting sponsored by the American Standards Association.

Speakers at the session on Where Are We in Screw-Thread Standardization? presented during the Seventh National Conference on Standards at the Hotel Roosevelt, New York, N. Y., *left to right,* are Harvey Erdman, National Screw and Manufacturing Company; W. M. Hanneman, Illinois Tool Works; H. F. Phipard, Continental Screw Company; and F. P. Tisch, Mem. ASME, Pheoll Manufacturing Company

The Clarification and Interrelation of Steel Specifications session speakers, *left to right,* are Joseph Gurski, Ford Motor Company; W. R. Miller, American Steel and Wire Division of U. S. Steel Corporation; N. L. Mochel, Mem. ASME, Westinghouse Electric Corporation; D. H. Ruhnke, Republic Steel Corporation; and J. Robert Walgren, chairman, ASA Company Member Conference, Aluminum Company of America

Division, Pheoll Manufacturing Company, delivered the opening address for the session on "Why Screw-Thread Standards Must Be Everybody's Business."

Mr. Tisch stated: "Both Sectional Committee B1 and the Interdepartmental Screw Thread Committee have come to grips with a vexing problem of many years standing—one which gave rise to numerous misunderstandings and controversies between purchasers and suppliers of threaded products.

"All American Standards are voluntary," he continued, "and the user may deviate from them as he sees fit. If the user chooses to follow the new thread standards he will get what has always been regarded as a commercially acceptable product, and also a product which is more specifically defined than ever before. If on the other hand, the standard product is regarded as not meeting a given set of requirements, it is always possible to specify the thread in further detail in procurement documents."

A panel discussion followed Mr. Tisch's address.

Harvey F. Phipard, Continental Screw Company, presented the second address in this session, "Slotted and Tapping Screws and Metallic Drive Screws." He said, "Now tapping screws have grown so in importance and variety that their new standard overshadows the parent standard in both size and scope. This presentation of the tapping screws in a publication of their own is one of the most important improvements in the screw standards in recent years. Even the producers of screws could not tell for sure that many of the tapping-screw dimensions were from the old standard, but each kind and type is completely covered in the new standard.

"The new standard also gives all the formulas used in setting up the tables of dimensions so that, when needed, unlisted screws, or even completely special screws, can be designed to keep as close to the standard as possible for the use intended. Here, too, easier manufacture will show up as savings to the user," he concluded.

A panel discussion also followed Mr. Phipard's address.

N. L. Mochel, Mem. ASME, manager, metallurgical engineer, Westinghouse Electric Corporation, was moderator for the session on "Clarification and Interrelation of Steel Specifications."

Joseph Gurski, assistant manager, manufacturing research department, Ford Motor Company, suggested a proposal to allow manufacturers all possible freedom in the selection of materials and processes as long as the end requirement is met.

H. W. Heinrich, Mem. ASME, chairman, Uniform Boiler and Pressure Vessel Laws Society, Inc., prepared a paper on "Uniform Boiler and Pressure Vessel Laws" for the session on "After the Standard—What Next?"

In his paper, which was presented by J. L. Menson, Mem. ASME, of Combustion Engineering, Inc., he stated: "After the standard there comes acceptance and then application. Clearly the standard must be the beginning, but standards do not have the force of law unless legally approved and adopted, nor do they have real value in any case unless those who should abide by them know of their existence and recognize their value to the point of voluntary acceptance and application.

"Our society does not lobby, it advises, explains, and assists. Years of such work are sometimes required before action finally culminates in a good law and then the job is to keep it from being sabotaged by improper rules and regulations."

He concluded, "Our work and our answer is—promote the recognition, adoption, and application of the standard, sell it, advertise it, explain and defend it, describe its benefits, and do these things with conviction, resourcefulness, and resolution."

At a session concerned with "Standardization and Atomic Energy," Harvey Wagner, Mem. ASME, mechanical engineer, The Detroit Edison Company, spoke on "Standardization Problems of a Reactor Designer." He stated: "When a new field is entered, the lack of adequate and acceptable standards and specifications suitable to meet new requirements is immediately evident. The use of nuclear energy as a heat source for steam-power production constitutes a completely new field in power generation and presents many unique problems for which standards, specifications, and codes are not available. In certain areas pertaining to power generation by nuclear means, the optimum time for the preparation of standards is here."

He added, "The following are merely mentioned to indicate some needs for new standards and codes:

1 Fire-fighting standards and equipment
2 Standards for stand-by equipment such as pumps and auxiliary electrical supply
3 Specifications for shielding grades of materials such as lead, polyethylene, and multipurpose materials such as high-boron steels
4 Procedure for testing mechanical safety devices
5 Standards for sampling methods and measuring the activity of radioactive wastes
6 Standards for tanks and containment facilities for handling and transporting radioactive materials and wastes.

Concluding, he said, "Although the nuclear energy technology is changing and will continue to do so for some time, much standards work can and should be done now before a multiplicity of individual standards and specification procedures results in chaos in the industry."

He stressed the need for "absolute leak-tightness of systems and components" in the nuclear field.

Morehead Patterson, Mem. ASME, chairman and president, American Machine and Foundry Company, sounded a warning at this session: "Unless national standards for atomic power are established, we shall find ourselves faced with an infinite variety of standards which will drive a reactor designer or manufacturer crazy if he tries to build in different localities. Unless national codes are set up, states and municipalities will start setting up their own laws and a confusion will result worse than the divorce laws in the forty-eight states."

Other sessions of the conference covered "Chemical Industry Standards—Management Views and Mutual Benefits"; "Dollar Savings Through Standards—Case Histories at the Company Level"; and "Standards to Prevent Death and Destruction—Everybody's Business."

Annual Awards Luncheon

At the closing session of the conference, two gold medals, the nation's highest awards in voluntary standards, were presented to the recipients.

Frederick S. Blackall, jr., past-president and Fellow of ASME, president and treasurer of the Taft-Peirce Manufacturing Company, received the Howard Coonley Medal for "great service in advancing the national economy through voluntary standards."

Charles Rufus Harte, construction engineer of the New York, New Haven and Hartford Railroad Company, was named to receive the Standards Medal, awarded annually for leadership in the development and application of industrial standards.

In his acceptance speech, Mr. Blackall said a revolutionary change has taken place in this country in the attitude industrial competitors hold toward one another.

"In my own industry and many others," he continued, "competitors are now more often than not the best of friends, not only willing but anxious to extend to each other the fullest measure of co-operation in all matters except that of getting the order, in which they still vie with each other down to the last ditch."

This gold medal has been awarded previously to Herbert Hoover, Senator Ralph Flanders, and William L. Batt.

In describing industrial economies accomplished through national standards, Mr. Blackall said that the Western Electric Company estimates that American Standards for tools and gages have saved it more than $15 million during the past 25 years, and that by purchasing American Standard thread sizes in the millions of screws it buys, it saves at least 20 per cent of former costs.

In stressing the importance of international standards to our national security, he declared, "The adoption of a common screw-thread standard by the United States, Britain, and Canada is a more effective bond of alliance with the other nations of the free world than a dozen treaties of undying friendship and mutual support. Indeed, it is one of the few things which gives practical meaning to such treaties."

For more than a quarter of a century, Mr. Harte, who received the gold Standards Medal, has been chairman of the ASA Board responsible for guiding and approving national standards in the electrical field.

Mr. Harte, who is 85, spoke on the development of the standards movement in the U. S. from the year 1911 to the present.

Clearly and concisely, he related how the introduction of electricity into the industrial scene early in the century worked a great change in the general attitude toward industrial accidents.

"Until 1913," he said, "the tragic toll of industrial injuries and deaths was largely regarded with the same callous indifference we show today toward automobile casualties."

Election of Officers

An election of officers and members of the board of directors for 1957 was held by letter ballot.

Mr. Hallowell was re-elected president.

Van H. Leichliter, vice-president, operations, American Steel & Wire Division, United States Steel Corporation, was re-elected vice-president of the Association.

Arthur S. Johnson, vice-president, American Mutual Liability Insurance Company, Boston, Mass., was re-elected chairman of the Associations Standards Council which supervises the technical work on standard specifications, dimensions, methods of test, and safety requirements in a broad range of activities. T. E. Veltfort, manager, Copper and Brass Research Association, who is the Council's vice-chairman, was also renamed to his post.

ECPD 24th Annual Meeting Held in Detroit, October 25-26

The 24th annual meeting of Engineers' Council for Professional Development, which was held in Detroit, Mich., Sept. 25 and 26, 1956, offered a full program of open sessions, executive sessions for the conduct of official business, committee meetings, and the presentation of committee reports, in addition to two luncheons, a reception, an annual dinner, and special activities for the women in attendance.

The engineers and their guests were greeted by Mayor Albert E. Lobo, who was introduced by Earnest Boyce, president, Engineering Society of Detroit, hosts for the meeting.

Public Sessions

Thursday's public sessions were devoted to the ECPD program, The First Five Years of Professional Development, particularly the program being carried out in Detroit. At the morning session George A. Porter, chairman, Sponsoring Group, Detroit Industry Training Committee, and vice-president, The Detroit Edison Company, presided and addresses were delivered by John J. Cronin, vice-president, General Motors Corporation; Clement J. Freund, Dean of Engineering, University of Detroit; and A. C. Monteith, vice-president, Westinghouse Electric Corporation. Three separate panels were offered in the afternoon; "An Orientation, Training, and Appraisal," conducted by Max W. Johnson, general supervisor, Personnel Development, Engineering Division, Chrysler Corporation; "Continued Education and Selected Reading," conducted by Kenneth A. Meade, director, Educational Relations Section, General Motors Corporation; and "Professional Identification and Integration Into the Community," conducted by Howard P. Seelye, engineering consultant. A summary of the panels was presented at the afternoon session, Edwin L. Yates, chairman, Detroit Industry Training Committee, presiding.

Friday morning offered an opportunity to conduct open meetings of ECPD's principal committees and Friday afternoon for presentation of the annual reports, which had been preprinted and distributed for that purpose.

The Thursday luncheon, at which Thorndike Saville, ECPD president, presided, was addressed by Dr. Kenneth McFarland, educational consultant for General Motors Corporation. N. W. Dougherty, dean emeritus, College of Engineering, University of Tennessee, was the speaker at Friday's luncheon.

"ECPD, Retrospect and Prospect" was the title of Dean Saville's talk at the annual dinner at which past-presidents of the Council, presidents of participating societies, and representatives of local engineering organizations were introduced. J. H. Foote, president, Commonwealth Associates, Jackson, Mich., delivered the address.

Detroit Industry Training Program

It will be recalled that a committee of ECPD worked up a Six Point Program several years ago in the hope that it would be undertaken in many industrial communities throughout the nation to provide a sense of purpose and direction to young engineers during their first five years after graduation. The program was adopted by a group of representative industries and educational institutions in Cincinnati, and later in Detroit. The Industry Training Committee, Detroit area, in co-operation with the Engineering Society of Detroit, has issued a number of attractive booklets on the Detroit Industry Engineering Training Program for the purpose of bringing to the attention of employers of young engineers in Detroit industry the need and advantages of development programs. These booklets bear the titles "General and Introductory Booklet," "Orientation and Training in Industry," "Continued Education," "Professional Identification," "Reading Lists for Engineers," "Appraisal and Counseling on Performance," and "Integration Into the Community." Inquiries about these booklets should be addressed to Industry Training Committee, Engineering Society of Detroit, 100 Farnsworth Ave., Detroit 2, Mich.

ECPD Chairman's Report

Appointments to ECPD, affiliation of ECPD and EJC, and the Survey of the Engineering Profession were the major subjects covered by Thorndike Saville in the President's Report to ECPD. Dean Saville said that the group of men serving ECPD "constitutes too small a segment of engineers engaged in the design, construction, and administration of substantial engineering enterprises" and that appointments to ECPD by the constituent organizations too rarely include member of the governing boards of these organizations. "Indeed," he continued, "the reactions of certain of such boards during the past two years would seem to indicate either a serious lack of liaison between these boards and their designated representatives on ECPD, or a lack of interest. If these governing boards were better informed," he contended, "and if their activities and accomplishments were more

widely publicized to the individual memberships through the medium of society publications, there would be less criticism among the rank and file of the profession as to alleged lack of concern of the societies with matters other than the presentation of papers or technical committee work."

On the subject of an affiliation of ECPD and EJC, Dean Saville said in part: "The two organizations have never worked together more cordially than in recent years. There are various areas of mutual concern. The effectiveness and efficiency of both would be materially advanced if there were some form of official affiliation." He then cited some of the advantages of affiliation and admitted that disadvantages could be found. "The form and method of affiliation which might prove most satisfactory," he stated, "may well be referred to the Planning Committees of the two organizations to develop jointly for consideration."

As an example of recent collaboration between EJC and ECPD, Dean Saville cited the proposed Survey of the Engineering Profession contained in the report of the joint ECPD-EJC Task Committee on a Survey of the Engineering Profession. The text of this report will be found on pages 1128–1130 of this issue of MECHANICAL ENGINEERING, a careful study of which is commended to all engineers.

[During its 24th annual meeting ECPD voted to accept and endorse the report of the ECPD-EJC Joint Task Committee and instructed its executive committee to continue implementation of the recommendations. Six pledges of society financial support (ASCE, AIME, ASME, AIEE, AIChE, and ASEE) have already been received—Editor.]

Guidance Committee

Bringing student guidance to an increasing number of secondary schools, especially in the outlying districts, has been continued, according to the report of the Guidance Committee. Special effort has been given to starting guidance work with 8th and 9th-grade students.

A revised fourth edition of the folder, "After High School—What?" is to be mailed to all superintendents and principals of all secondary public, private, and parochial schools. A second mailing to all counselors of these secondary schools of a reprint of "Accredited Curricula Leading to First Degrees in Engineering" andt he folder "After High School—What?" is also planned.

The booklet "Engineering—A Creative Profession" has been revised and is in its third printing. A new edition of a manual for counselors and others active in student-guidance work has been published.

Forty-three state chairmen report 1650 schools visited and 118,260 students met. Schools in large cities sponsoring Career Days are not included in these figures.

Michigan State University sponsors the organization of JETS (Junior Engineering Training Schools). Although young, this organization has set up 86 clubs in 19 states.

The committee reports that local sections of national societies can assist in guidance work if they will find out whether there is an active guidance committee in their community. If there is, offer to co-operate; if there is not, organize one.

Extended efforts are planned by the committee to interest industry in purchasing the ECPD booklet "Engineering—A Creative Profession" for free distribution to high-school students.

Education and Accreditation

Additional critiera for engineering curricula were prominently featured in the report of the Education and Accreditation Committee, as follows:

The impact of accelerating technical sophistication in industry and defense is being felt in our engineering schools, through several channels. One of the most important channels is the Evaluation Committee report of the American Society for Engineering Education, accepted in June, 1955. Related to and in some sense growing out of this report are the "Additional Criteria for Engineering Curricula," appearing as part of last year's report of this committee. These have had the general effect of raising the sights both of engineering education and of ECPD standards for engineering curricula. There is a widespread recognition that the art of technology and engineering practice must take a role secondary to sound grounding in science, and the development of these methods of thought by which science can be applied with understanding and judgment to the solution of new problems. The degree of acceptance of these ideas and of the essential place of general education in an undergraduate engineering curriculum has been indeed notable across the country.

Simultaneously with these raised levels of performance that engineering educators have set for themselves, inflationary effects have appeared that work against achievement of these levels. Employers of engineering graduates strive mightily to increase the attractiveness of industrial employment at the same time that general economic inflation is decreasing the attractiveness of an academic career in comparison with an industrial career. The effects of these trends on faculties pose problems in appraisal and judgment to ECPD visiting committees that are at once challenging and difficult. Engineering faculties, especially in smaller departments, tend now to be much less stable than in less dynamic times, and the committee finds necessary a correspondingly large number of short-term recommendations. However, in attempting to minimize the burden on institutions, increasing use is made of letter reports in lieu of inspections to extend short-term approvals. This is proving to be a valuable mechanism in those cases where quality is good, but where it could change rapidly.

The first year of experience in experimental application of the Additional Criteria indicates their significance as a tool of thought. Some concern has of course been expressed that these criteria would be used to call for sudden curriculum changes because of rigid interpretation and application. These fears appear to have been largely removed by the committee's emphasis on the idea expressed in the criteria that "they are regarded as a statement of principles to be applied with judgment in each case rather than with arbitrary rigidity." When used as a guide, these criteria have brought into clearer focus a number of problems that have concerned the committee in past years. There are curricula that are recognized as good and serving a useful purpose, but whose engineering character has been repeatedly questioned. Application of these criteria shows much more clearly than before—not in terms of rules or credit hours but in terms of general principles—if and how these curricula fall short of an acceptable minimum as engineering. Even when withdrawal of accreditation is indicated, time is allowed for a deliberate and orderly handling of the situation involved. The committee is also inclined to apply these criteria somewhat liberally in the case of curricula whose intellectual and scientific quality are recognized as distinctly high in comparison with acceptable curricula of a more conventional engineering pattern. The committee feels that the Additional Criteria should continue to be an important guide in its whole operation.

We have had support for the principle stated in the Additional Criteria "that the engineering student taking advanced military science is in effect pursuing two curricula simultaneously with separate and different requirements and objectives," and that as a consequence such a dual-purpose curriculum may require more time than a single-purpose program directed toward an engineering degree alone.

This is clearly a large problem involving the national interest, in which educational ideals must be expressed with wisdom, judgment, and sense of timing.

The report further stated that relations with regional associations continued to develop, that increasing interest and participation on the part of professional societies in the work of the committee was encouraging and helpful, that attention had been focused on technical-institute education, and that it appeared inevitable that an increase in charges for accreditation would be necessary.

Student Development

Interest in professionalism was noted in the report of the Student Development Committee.

Reference was made to a study of "drop outs" of engineering students made by the University of Missouri in the report, which summarized the problems as follows:

1 Lack of guidance in high school.
2 Lack of good preparation for engineering.
3 Need for better orientation, advisement, and student staff understanding.
4 Knowledge of the requirements in engineering causes the student to change to some other activity.
5 Many of the dropouts thought the engineering program was not practical enough, though very few of them thought there should be a reduction in mathematics.

The report stated the committee's belief that strong student chapters of the ECPD constituent societies aid in developing group spirit and in promoting professional activities within the colleges. Engineering societies profit by student membership because many beginning members are transfers from student chapters.

"The neophyte engineer," the report stated, in reference to society membership, "can obtain many benefits through active membership, committee work, and meeting attendance. A few of these advantages are:

"1 The opportunity to meet and talk with leaders in his profession.

"2 Provision of a dignified and ethical method of advertising his own ability through work on committees and by presentation of papers.

"3 The chance to become known personally by senior engineers of his own and other companies.

"4 Through meeting attendance to keep abreast of the newer developments in engineering.

"5 The opportunity to meet new people of similar background and interests and thus to make new friendships.

"6 The possibility of further developing the all-important quality of leadership through committee work."

Training Program

Major attention of the Training Committee has been focused on activities designed to implement "The First Five Years of Professional Development" program. The report of the committee highlighted recent developments in this program in Detroit, Cincinnati, Minneapolis, and Canada. During the year 5000 copies of the brochure, "The First Five Years of Professional Development," had been ordered.

Professional Recognition

The following definition of engineering was suggested in the report of the Recognition Committee: "Engineering is the profession in which a knowledge of the mathematical and physical sciences gained by study, experience, and practice is applied with judgment to develop ways to utilize, economically, the materials and forces of nature for the progressive well-being of mankind."

The committee reported that it has agreed to undertake a restudy of the grades of membership of the constituent societies.

Studies of a suggestion that the profession provide itself with a new designation to replace "Professional Engineer" are being undertaken.

In respect to the problem of developing and maintaining the interest of young men in the engineering profession, the report stated:

"Since professional service is basically a service of individuals who have individual responsibilities, it behooves those of us having engineers under our direction to guide each one in his professional development. Our Training Committee has established guideposts to assist in orientation of the young engineer, encouraging his self-development through self-analysis and continuing study. We can encourage him to participate actively in his engineering society. A professional man will willingly accept the privilege of serving his profession. He should attend meetings and present papers. He should participate in leadership through committee work and Section activities. He should advance to Associate Member and full Member grade as he becomes eligible. When he is qualified he should establish his legal standing by registration as a Professional Engineer.

"In his day-to-day work as he acquires judgment and is responsible for engineering work, it should be recognized. Why should not drawings and specifications be certified by the young registered engineers who actually do the engineering work, as well as by the head of the department in charge? This would aid in the prestige of the growing engineer. It would serve to recognize him as an individual professional man rather than as a doer of routine work."

Ethics

"Over a period of years, in excess of 80 engineering societies have endorsed the Canons of Ethics, and several of them have adopted the Canons as their own codes of practice and ethics," stated the report of the Ethics Committee. It is the intention of the committee "to concentrate upon the creation of much greater interest in ethics among engineers, particularly as a means for increasing professional understanding and consciousness among them."

Procedure

The committee believes that concern about and understanding of ethics among engineers can be substantially improved by:

1 Holding open sessions in annual meetings of ECPD for consideration of specific questions and problems pertaining to engineering ethics.

2 Exerting influence upon constituent and other engineering societies to hold sessions for the consideration of ethics; and assisting them in arranging programs.

3 Exerting influence for the publication of articles and papers in the field of ethics in the journals of constituent societies, and in other engineering and technological periodicals.

4 Publication of a suitable brochure to contain the Canons, and the codes or regulations of professional practice of the constituent and other important engineering societies.

5 Publication of pamphlets or handbooks on ethical procedure to contain, respectively:

(*a*) Ethics for engineering employers and for engineering organizations
(*b*) Ethics for engineers who are engaged simultaneously by several employers or clients
(*c*) Ethics for the recruitment of engineers
(*d*) Ethics for students
(*e*) Ethics for registered engineers.

Information Committee

The ECPD Information Committee, which consists of the editors of the constituent societies, reported that its publication fund had grown from $12,844.33 as of August, 1955, to $17,784.51. All but 20 per cent of the sales of publications is credited to this fund. The current status of the several ECPD publications was reported.

(J. J. Jaklitsch, Jr., acting editor of MECHANICAL ENGINEERING, replaces George A. Stetson, editor emeritus, on the Information Committee.)

Practice of Engineering

Consideration of corporate practice, the responsibilities of partnerships, and reciprocation in licensing constituted the assignment of the ECPD-EJC Joint Committee on Practice of Engineering. The statements of the committee in respect to these matters are as follows:

Corporate Practice

With reference to corporate practice, the committee recommends that it be the policy of EJC and ECPD that.

Under certain conditions, corporations should be allowed to provide engineering services.

In an engineering corporation a majority of the officers, as well as those responsible for the engineering work, must be registered professional engineers in the state of incorporation, and the engineers supervising work must be licensed in the state in which the engineering duties are performed.

Partnerships

The committee is of the opinion that the usual obligations of partnerships are very clear in the law. It also recognizes that questions of ethics, by their nature, go beyond law, and it is the unanimous recommendation of the committee that our boards go no futher in questions of partnerships than to recommend that the Codes of Ethics of the constituent societies be made absolutely clear on the point.

Reciprocity in Licensing

The committee recommends full reciprocation in licensing between states that have approximately equivalent requirements.

The committee does not recommend reciprocation in licensing between States that do not have approximately equivalent requirements.

This committee urges the EJC and ECPD to apply all proper influence though through their members, constituent societies, and local sections to bring the requirements of various states up to a proper level so that reciprocation can become fair and practical between all states.

Previous Recommendations

"By action of the EJC board at its March 7th meeting, we have been requested to include in this report two previous recommendations as follows:

"Professional responsibility for engineering work is a personal responsibility, and that personal responsibility should be recognized by all laws relating to the registration or licensure of the professional engineer. Therefore the person or persons in responsible charge of professional engineering practice must be legally registered professional engineers and there should be no discrimination by implication, omission, or direction as to the form of business organization, individual, partnership, corporation, or other.

"We recommend that it become the stated policy of EJC that registration should be a requirement for the practice of engineering, and that it encourage member societies to recognize registration as an important step in professional development."

ECPD Officers Elected

Morris D. Hooven, Mem. ASME, Public Service Electric and Gas Company, Newark, N. J., and past-president AIEE, was elected president of Engineers' Council for Professional Development at the 24th ECPD annual meeting. He succeeds Dean Thorndike Saville, New York University College of Engineering.

Russell G. Warner, Mem. ASME, vice-president, the United Illuminating Company, New Haven, Conn., and past-president NCSBEE, was elected vice-president, ECPD; and E. O. Kirkendall, Jr., secretary, AIME, and T. A. Marshall, Jr., assistant secretary ASME, were elected secretary and assistant secretary, respectively.

Each of the eight participating bodies of ECPD has three representatives on the Council. The new appointments announced at Detroit are:

W. S. Evans, University of Maine (ASCE), W. H. Larkin, The Air Preheater Corporation, New York, N. Y. (ASME); M. D. Hooven (AIEE), G. R. Henderson (EIC), and F. C. Linvall, Mem. ASME, California Institute of Technology, Pasadena, Calif., (ASEE).

Chairman of the standing and special committees of ECPD are: Guidance, K. F. Treschon, Mem. ASME; Education and Accrediting, W. L. Everitt; Student Development, R. C. Ernst; Training, E. L. Yates; Recognition, G. H. O'Sullivan; Ethics, C. J. Freund, Mem. ASME; Information, R. A. Beals.

UPADI Holds 4th Convention in Mexico City

Scholarships for Engineers and Establishment of Technical Institutes Urged

Almost 200 engineers from 16 countries attended the fourth Convention of UPADI, la Union Panamericana de Asociaciones de Ingenieros, held in the beautiful new building of the Secretariat of Communications and Public Works in Mexico City, D. F., Mexico, October 8–12. Mexico of course led in attendance, with Brazil second, followed by the United States and Cuba.

His Excellency don Adolfo Ruiz Cortines, President of Mexico, formally opened the Convention which was also addressed by James M. Todd, past-president and Fellow ASME, chairman of the Engineers Joint Council delegation, on behalf of UPADI president Luis Giannattasio. Gail Hathaway, chairman of the EJC Committee on International Relations, greeted the Convention on behalf of the North American engineering societies.

33 Resolutions Considered

The Convention considered 33 resolutions, defeating one for the establishment of a Pan American Institute of Electricity, tabling another on budget, and passing the rest. The Convention urged that formal sessions on engineering education be held simultaneously with future conventions of UPADI, that scholarships be made available to engineers for study in other countries, that technical institutes be established for technicians and foremen.

It suggested the compilation of a dictionary of common engineering terms and requested close co-operation with the Pan American Committee on Technical Standards. The need for creating national standards organizations was particularly noted. The U. S. and Canadian delegations were invited to secure the adoption of the metric system in their respective countries. Montevideo, Uruguay, was once again selected as the site of the UPADI headquarters, and Montreal, Que., Canada, was chosen for the 1958 meeting site.

Round tables on atomic energy and engineering education proved to be the high light of the technical sessions.

ASME Officials Welcomed

A special dinner meeting was organized on October 10 by the ASME Mexico Section to welcome various ASME officials attending the Convention. Honor guest was national president Joseph W. Barker. Past-president Robert McFarland Gates, Secretary C. E. Davies, and Miguel Montilla Molina also attended. The latter was acting-president of the UMAI, Union Mexicana Asociaciones Ingenieros, which carried out all of the preparatory and planning arrangements for the UPADI Convention.

Officers of the Convention were: President, Miguel Alberto Mantilla of Mexico; vice-presidents, Adolph Ackerman of the U. S. Saturnino de Brito, filho of Brazil, Harra Trippenhammer of Haiti; Secretaries, Estebay Manuel Vega of Mexico, Galo Yepez of Ecun-

Miguel A. Mantilla, president of la Union Mexicana de Asociaciones de Ingenieros and president of the Convention, receives a watch from Gail A. Hathaway, vice-chairman of the U. S. delegation. *Left to right* are Mr. Hathaway; G. E. Montes, a U. S. delegate; Mr. Mantilla; Stewart E. Reimel; and Walter E. Lobo, another of the U. S. delegates.

Luis Giannattasio, president of UPADI, receives a Hamilton Time Zone watch from Joseph W. Barker, ASME president and nominee for president of EJC for 1957. *Left to right* are James M. Todd, chairman, U. S. delegation; Dr. Barker; George E. Brandow, delegate from Los Angeles, Calif.; and Dr. Giannattasio.

One of the sessions in the beautiful new building of the Secretariat of Communications and Public Works where all meetings of the UPADI Convention were held

The audience at one of the sessions of UPADI. ASME Secretary C. E. Davies is the first figure in the front row. Seated next to him is L. Austin Wright, executive secretary of the Engineering Institute of Canada.

dor, Juan Ignacio Planas of Cuba, Tate Erwin of Canada, Alirio Cornejo of El Salvador.

Atomic Energy Round Table

At the round table on atomic energy, Dr. Clark Goodman, of the U. S. Atomic Energy Commission, reaffirmed his country's policy to share its peaceful applications of atomic energy with the Latin American nations. The United States is assisting in the manufacture of nuclear reactors and is making research facilities available to Latin American scientists.

A number of Latin American nations have signed agreements with the United States on nuclear research and three others are currently being negotiated. The Convention urged the western hemisphere nations to draw up uniform legislation on atomic energy and provide for complete exchange of information on raw-materials availability and resources. It asked for a report at the next Convention on progress in the search for mineral deposits, production figures, and the uses of radioactive isotopes in agriculture, industry, biology, and medicine.

The round table on engineering education was conducted by Lee H. Johnson, dean of the School of Engineering, Tulane University, New Orleans, La., and Ralph Morgen of the Purdue Research Foundation, Lafayette, Ind., was a principal speaker.

AAAS Program of Section M, Engineering, Takes up Aids for Environmental Control

The program of Section M, Engineering, to be presented during the American Association for the Advancement of Science, in the Grand Ballroom of the Hotel Statler, New York, N. Y., December 26 and 27, 1956, was announced recently.

The program is keynoted by the general theme, "Aids for Environmental Control," and will be presented in three sessions. These sessions are cosponsored by the AAAS Sections C-Chemistry; H-Anthropology; I-Psychology; K-Social and Economic Sciences; L-History and Philosophy of Science; N-Medical Sciences; and X-5-Conference of Scientific Manpower.

The tentative program is as follows:

WEDNESDAY, DECEMBER 26

9:30 a.m.

Session 1—Overcoming Normal and Abnormal Physical Limitations

Chairman: *Eugene F. Murphy*, Veterans Administration, New York, N.Y.

Ability and Limitations of Normal Man, by *Dr. M. W. Lund*, Office of Naval Research, Washington, D.C.

Instrumentation for Bioengineering, by *W. E. Frank*, The Franklin Institute, Philadelphia, Pa.

Some Biomechanical Methods for Evaluating Activities, by *Anthony Staros*, Veterans Administration, New York, N. Y.; *Dr. Rudolfs Drillis*, New York University; and *William Romahn*, Veterans Administration, New York, N. Y.

Discussion will be opened by *Renato Contini*, New York University

2:00 p.m.

Session 2—Extending Mental and Rational Powers

Chairman: *Irving P. Orens*, Newark College of Engineering

Biomechanics in Crash Mortality: The Surgical Approach Co-ordinating Man's Built-in Crash Defenses, by *Dr. C. M. Gratz*, New York, N. Y.

Extending Mental Processes by Analogs, *Dr. J. R. Ragazzini*, Columbia University

Harnessing the Digital Computers, by *Dr. R. W. Hamming*, Bell Telephone Laboratories, Murray Hill, N. J.

Discussion will be opened by *Prof. F. A. Russell*, Newark College of Engineering

THURSDAY, DECEMBER 27

9:00 a.m.

Session 3

Chairman: *John Lotz*, Columbia University

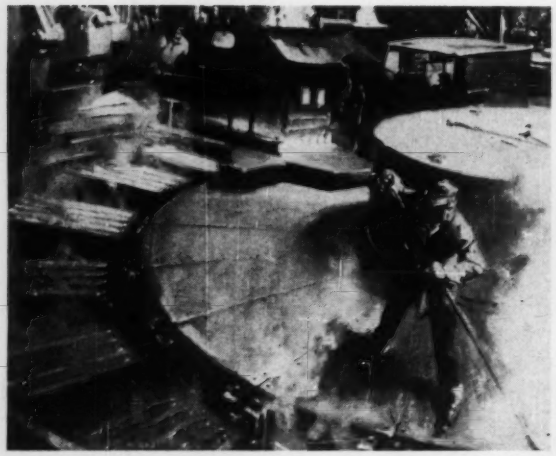
Translating Teletypesetter Tape to Braille by *Sidney Friedrich*, Republic Aviation Corp.

Reduction of Speech Signals for Easier Transmission, by *Dr. Sze-Hou Chang*, Northeastern University

Mechanical Translation of German, by *Dr. V. H. Yngve*, Massachusetts Institute of Technology

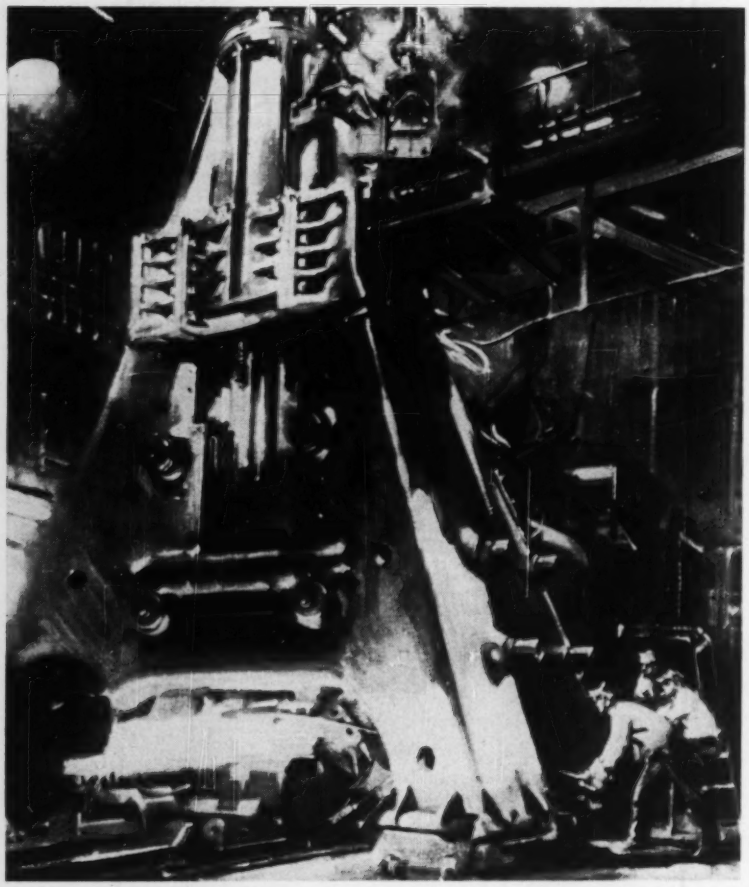
Mechanical Translation of Russian, by *Dr. A. G. Oettinger*, Harvard University

Discussion will be opened by *Charles Ritter*, American Foundation for the Blind; *Dr. F. S. Cooper*, Haskins Laboratories; *Dr. K. N. Stevens*, Massachusetts Institute of Technology; *Homer Dudley*, Bell Telephone Laboratories; and *G. S. Fielstra*, New York Public Library



The wire-bar casting wheel at the Copper Refinery, Copper Cliff, Ontario. Millions of miles of copper wire started life as wire bars cast on this machine.

The testing of magnetic alloys. The magnetic properties of a metal give vital clues to its structure and help in the development of new and improved alloys.



Forging hammer at the International Nickel Company's Huntington, W. Va., works. Nickel-chromium alloys are tough even at very high temperature and need the heavy treatment of this giant forge to break down the cast ingots.

Portrait of an Industry

"Paintings of Industry," an exhibition of oils by Terence Cuneo, was shown recently at Grand Central Art Galleries in New York, N. Y. The show featured Mr. Cuneo's interpretation, in 19 paintings, of the operations of The International Nickel Company and its affiliates in mine, plant, and laboratory in the United States, Canada, and the United Kingdom.

International Nickel's commission to Mr. Cuneo highlights a growing trend of financial support for art and the artist from the business community. With the decline of great individual fortunes, and, perhaps, because of our tax structure, business is in the best financial position to encourage artistic talent on a broad scale through direct commissions to artists.

International Nickel has for a number of years commissioned artists here and abroad to interpret the company's operations on canvas for use in advertisements and company publications.

The company's extensive and varied operations are well illustrated by these paintings and they range from depicting the remoteness of miners working some 2000 ft or more below ground with only the illumination glowing from their lamps, to the glare and activity associated with the converter aisle or the massive action of a forging hammer or extrusion press.

Reproduced here are photographs of three of Mr. Cuneo's original oil paintings.

Plans for Engineering Center Due Early in 1957 Says UET

Founder Societies take steps toward engineering capital of world

UNITED ENGINEERING TRUSTEES, INC., the joint corporate agency of the four major national engineering societies, of which The American Society of Mechanical Engineers is one, has signed a contract for preliminary architectural plans and studies for a new Engineering Center in mid-Manhattan, New York City. This is the first definite step toward construction of what is expected to make New York the "engineering capital of the world."

Announcement of the granting of the contract came with announcement of the re-election of Walter J. Barrett, of Glen Ridge, N. J., as president of UET. It was, also, the first formal revelation that all the four member societies of UET, and a fifth that is expected to become a member, had voted, through their governing boards, to remain in New York. Several other cities had striven to obtain the Center.

Architects Named

The architects named are Shreve, Lamb and Harmon Associates of New York, designers of the Empire State Building and more recently the Brooklyn Supreme Court Building. The announcement did not indicate any details as to specific location, cost, or time of completion.

The present 16-story quarters, known as the Engineering Societies Building, house the four "Founder Societies," the American Society of Civil Engineers, the American Institute of Mining, Metallurgical and Petroleum Engineers, The American Society of Mechanical Engineers, and the American Institute of Electrical Engineers. A fifth prospective "Founder Society," the American Institute of Chemical Engineers with headquarters presently elsewhere in New York City, will be included in the Center project. At a recent meeting at which Mr. Barrett was re-elected and the architectural contract granted, the Board of Trustees of UET approved the American Institute of Chemical Engineers as a member. This action awaits ratification of the other four Societies. Occupants of the Engineering Societies Building include Engineers Joint Council, which is composed of ten major national engineering societies, including the five in the Founder group.

Preliminary Plans Due in 1957

It is believed that preliminary plans will be completed early in 1957. The inclination toward a mid-Manhattan site is due to appreciation of accessibility of railroad and airline terminals and convention hotels.

Financing is expected to run into "several million dollars." In addition to the contributions of the various Founder Societies and their members, UET, which has been charged with the responsibility of the planning, construction, and financing of the new structure, has received assurances of the co-operation of a group of industrialists and educators toward the required fund. This group, headed by Mervin J. Kelly, president of Bell Telephone Laboratories, Inc., stated on June 8, 1955, in a letter to UET and its constituent societies, its readiness to assist in this direction on the selection of a city following a broad and careful study of all possible sites with national rather than local interests to be the determining factor.

In a statement announcing the granting of the contract, Mr. Barrett said: "It is the sense of UET that the new Engineering Center presents a challenge to the profession. Engineers have planned, designed, and constructed outstanding structures of all kinds throughout the world. Now the profession faces the challenge of building for itself a Center that will reflect the profession's dignity and stature. It is not likely that the genius and imagination that have gone into the building and rebuilding of the modern world will fail to create in this instance an appropriate testimonial to the profession's achievements.

"UET was established 52 years ago 'to advance the engineering arts and sciences in all their branches and to maintain a free public engineering library.' It owns the Engineering Societies Building. Through The Engineering Foundation, it conducts research in engineering and scientific subjects for the advancement of engineering and for the good of mankind. The library is the largest of its kind in this country and works closely with the New York Public Library, the Library of Congress, and other institutions. UET acts in a fiduciary capacity for a large number of joint activities of the major engineering societies.

"As it became evident in recent years that the present quarters were inadequate, many cities pressed to have the new Center located in their communities. All these were given full consideration. A Special Task Committee of Fifteen, three from each of the five societies directly concerned, directed a study by an independent firm of management consultants and this Committee several months ago made recommendations which were presented to the governing boards of the five Societies. The governing boards have voted to approve the recommendation to remain in New York."

Eminent Leaders Pledge Support

The June 8, 1955, letter, signed by 21 men eminent in their fields of industry, engineering, science, and education, gave assurances, in the matter of financing the new Center, that "a well-organized, diligent, and competent effort will be made and continued until the required sum is available." The letter urged the designation of independent management consultants to make a thorough-going study of all considerations in the offers and invitations of the several cities. The letter emphasized that "we are agreed that the fundamental desirability of approaching this matter on a national rather than a local basis transcends our personal preferences."

The signers stated that "the long-range interests of the Societies in serving their professions and the nation are paramount" and that "maximum effectiveness of your operations is of controlling importance."

The letter went on to say: "Most industries of the country benefit directly from the technologies included in your organizations. We are sure they will contribute generously to your building funds if your location is chosen on the broad-gaged basis suggested. If such a choice is made, a group of the undersigned will organize a large national committee, representing all sections, all technologies in your Societies, and a variety of industries, to conduct a nationwide drive for funds."

Besides Dr. Kelly, the signers were: James F. Bell, Minneapolis, chairman, Committee on Finance and Technological Progress, General Mills, Inc.; Detlev W. Bronk, Hon. Mem. ASME, Washington, president, National Academy of Sciences; Ralph J. Cordiner, New York, president, General Electric Company; James Creese, Affiliate ASME, Philadelphia, president, Drexel Institute of Technology; Jess H. Davis, Mem. ASME, Hoboken, N. J., president, Stevens Institute of Technology; Lee A. duBridge, Pasadena, Calif., president, California Institute of Technology; T. Keith Glennan, Cleveland, president, Case Institute of Technology; Eugene G. Grace, New York, chairman of the board, Bethlehem Steel Corporation; Crawford H. Greenewalt, Mem. ASME, Wilmington, Del., president, E. I. du Pont de Nemours & Company; William H. Harrison (since deceased), New York, president, International Telephone and Telegraph Corporation.

Also, Livingston W. Houston, Mem. ASME, Troy, N. Y., president, Rensselaer Polytechnic Institute; Frederick L. Hovde, Lafayette, Ind., president, Purdue University; Kaufman T. Keller, Fellow, ASME, Detroit, chairman of the board, Chrysler Corporation; Horace P. Liversidge, Fellow, ASME (since deceased), Philadelphia, chairman of the board, Philadelphia Electric Company; John L. McCaffrey, Chicago, president, International Harvester Company; Alfred P. Sloan, Jr., New York, chairman of the board of directors, General Motors Corporation; Charles A. Thomas, St. Louis, president, Monsanto Chemical Company; Martin D. Whitaker, Bethlehem, Pa., president, Lehigh University; Robert E. Wilson, Chicago, chairman of the board, Standard Oil Company of Indiana; John D. Wright, Cleveland, president, Thompson Products, Inc.

McKinsey & Company, management consultants, surveyed all factors involved in the possibilities advanced by the several cities and recommended New York. In a report on June 22, 1956, forwarded to the governing boards of the Societies, the Special Task Committee of Fifteen reviewed the considerations involved and urged that midtown New York be approved.

It was suggested that if the present site

proved to be not feasible another location in midtown be chosen. The proposal required approval of each of the Societies. The final approval was voted recently.

New UET Officers Elected

Besides Mr. Barrett, officers elected by UET for the next year are: 1st Vice-President, Willis F. Thompson, Mem. ASME, (vice-president, Westcott & Mapes, Inc.); 2nd Vice-President, Andrew Fletcher (president, St. Joseph Lead Company); Treasurer, Joseph L. Kopf, treasurer and Mem. ASME, (president, Jabez Burns & Sons, Inc.); and Assistant Treasurer, George W. Burpee (partner, Coverdale & Colpitts).

People

Honors and Awards. RALPH BUDD, Hon. Mem. ASME, retired chairman of the Chicago Transit Authority, received The American Institute of Consulting Engineers Award of Merit for 1956. Presentation was made November 27 at the Institute's annual dinner at the Waldorf-Astoria Hotel, New York, N. Y., at which the principal speaker was Harlow H. Curtice, president of General Motors Corporation.

PETER E. RENTSCHLER, president, The Hamilton Foundry & Machine Company, Hamilton, Ohio, was honored by the Gray Iron Founders' Society with the association's highest award, the Gold Medal. The presentation was made at The Homestead, Hot Springs, Va., on Nov. 2, 1956, during the 28th annual meeting of the Society.

Among the leaders in the field of welding, honored for outstanding achievements at the official opening session of the American Welding Society's national fall meeting in Cleveland, Ohio, October 8, were: GEORGE E. LINNERT, head of welding research at the Armco Steel Corporation Laboratories, who presented the Adams Honor Lecture; CLARENCE E. JACKSON, research metallurgist, Metals Research Laboratories of Linde Air Products Company, who received the Samuel Wylie Miller Memorial Medal for researches that have contributed significantly to the art of welding; H. C. LUDWIG, research engineer, Westinghouse Research Laboratory, who received the J. F. Lincoln Gold Medal for the paper judged as the most original contribution to the advancement and use of welding. Two students, LEE E. ALLGOOD of the University of Michigan and GEORGE L. NEAL of the University of Denver, were awarded cash prizes for their outstanding welding articles that appeared in undergraduate publications.

A. E. GURLEY and C. R. HANNEWALD of the Chrysler Corporation, Detroit, Mich., received the annual Metals Treating Institute Achievement Award for the joint authorship of the outstanding feature article appearing in the magazine *Metal Treating* during the preceding year. The award was made during the annual meeting of the Institute held at the Hotel Cleveland, Cleveland, Ohio, October 5–7. The past-president's plaque was presented to C. M. COOK of the Cook Heating Company of Texas who had presided for two terms during 1954 and 1955.

HERMAN TACHAU of Santa Fe, N. Mex., an engineer with the New Mexico State Highway Department, received the First Award of $5000 in the recent competition for ideas to accelerate the progress of arc welding sponsored by The James F. Lincoln Arc Welding Foundation of Cleveland, Ohio. The award was one of 20 made to men in 16 states and totaling $20,000. The Second Award of $4000 went to VAN RENSSELAER P. SAXE, a consulting engineer of Baltimore, Md. T. C. KAVANAGH, a consulting engineer of New York, N. Y., received the $3000 Third Award. BRUCE G. JOHNSTON, a professor of structural engineering at the University of Michigan received $2000 and ORVILLE T. BARNETT and JOHN RUDY, both of the Armour Research Foundation of Chicago, shared the $1000 Fifth Award.

At the recent convocation of The Cooper Union for the Advancement of Science and Art, held in New York, N. Y., Oct. 6–9, 1956, to inaugurate its centennial program, panels of outstanding educationalists, engineers, scientists, and businessmen discussed the topic, "Tapping Hidden Resources for America's Future Engineers and Leaders." The convocation program included the presentation of citations to 25 distinguished alumni who were selected as the recipients of the first alumni citations that Cooper Union has awarded. Among those who received citations was FREDERICK KRUG, Mem. ASME, president of International Power Company, Ltd., Montreal, Que., Canada.

FRANK M. FOLSOM, president of the Radio Corporation of America, will receive the 1957 Gold Medal of Achievement as the climax of the Poor Richard Club's observance of the 251st anniversary of Benjamin Franklin's birth on January 17. The award will be made at the Club's 52nd annual dinner which will be held in the Bellevue-Stratford Hotel, Philadelphia, Pa.

Officers. THEODORE T. RENSHAW, a special representative in plant engineering for Lockheed Aircraft Corporation in Marietta, Ga., was elected president of The National Management Association for the coming year at the Association's annual meeting in St. Louis, Mo., on September 27. He succeeds GORDON R. PARKINSON, flight-planning superintendent for Trans World Airlines, Inc., Kansas City, Mo. Other officers of the Association include: first vice-president, ROBERT P. WALBRIDGE, Lakeside Bridge and Steel Co., Milwaukee, Wis.; secretary-treasurer, G. ELDON TUFTS, Sylvania Electric Products, Inc., Danvers, Mass.

Members of the Sigma Tau National Council were elected at the close of the three-day national convention held at Boulder, Colo., October 4–6, at which the University of Colorado Chapter served as hosts. CLAREL B. MAPES, a civil engineer of Tulsa, Okla., was advanced to the office of national president of Sigma Tau; M. H. COOK, vice-president of Bell Laboratories, New York, N. Y., will serve as vice-president of the National Council; and C. A. SJOGREN of Lincoln, Neb., will continue as national secretary and editor of the Council's quarterly publication.

Research. At the request of the government of Burma, WILLIAM M. RAMLOW of Decatur, Ill., has been assigned by the United Nations Technical Assistance Administration to help in the development of Burma's manufacturing industry. He will assist in the design, development, and selection of tools and equipment for the production of industrial and consumer goods suitable to the diversification of the Burmese economy.

Campus News. JOHN P. NIELSON, chairman, department of metallurgical engineer-

Special guests at the 25th Anniversary Dinner of the Kuljian Corporation, Philadelphia, Pa., held at the Barclay Hotel on October 15. Shown, *left to right,* are: The Honorable Richardson Dilworth, Mayor of Philadelphia; G. S. Tompkins and W. H. Brown, president and vice-president and treasurer, respectively, American Viscose Corporation; and the host, Harry A. Kuljian, Fellow ASME, and head of the firm bearing his name, who came to this country as a penniless Armenian immigrant boy 40 years ago.

The Nuclear Engineering and Science Congress General Arrangements Committee met at the Engineers Club, Philadelphia, Pa., October 29, to complete preliminary plans for the 1957 Nuclear Congress to be held in Convention Hall, March 11–15. The Committee seated, *left to right,* are R. R. Wagstaff, vice-chairman, Information Committee; J. S. Burlew, chairman, Printing and Signs Committee; R. L. Smith, AIME representative; C. S. Doerr, Engineers Club representative; W. E. Belcher, Jr., vice-chairman, ASME representative; Mrs. D. M. Shackleford, assistant manager, Nuclear Engineering and Science Congress; L. R. Gaty, chairman, General Arrangements Committee; Howard Gross, retired, dean, Spring Garden Institute; C. C. Peavy, Reception Committee, AIChE representative; G. E. Beggs, Technical Events Committee, AIEE representative; T. E. Stieber, chairman, Entertainment Committee; and R. W. Buntin, chairman, Hotel Committee. Standing, *left to right,* are S. R. Warren, Jr., chairman, Ladies' Committee; H. F. Grebe, exhibits manager, International Atomic Exposition; B. W. Webb, chairman, Publicity Committee; H. M. Chance, 2nd, chairman, Finance Committee; J. H. Ferguson, Transportation Committee, ASCE representative; J. V. Friel, director, International Atomic Exposition; T. A. Marshall, Jr., assistant secretary, ASME; and T. W. Hopper, chairman, Registration Committee. W. F. Henn, chairman, Information Committee, was unable to attend the meeting. Conducted by 20 major engineering and scientific societies, of which The American Society of Mechanical Engineers is one, under the leadership of the Engineers Joint Council, the Congress is expected to attract thousands of technical and business leaders from all parts of the nation.

ing, New York University, left for the Soviet Union, November 3, to lecture and attend a scientific conference. He was the guest of the Soviet Academy of Sciences for one month. He was invited to visit Russia by Dr. A. M. Samarin, leading Soviet steelmaking authority, while the latter was a "student" attending a one-week special course on titanum metallurgy at NYU. Dr. Nielson, who is noted for his theory on grain growth in metals and his research on titanium and x-ray diffraction, will lecture at the Institute of Metallurgy in Moscow, where Dr. Samarin is deputy director.

He will also attend a conference on atomic energy in Moscow and visit metals institutes and plants in other parts of the country. In addition, he will explore informally the question of the exchange of Russian and American students and professors. Officials of the State Department, who have approved Dr. Nielsen's visit, believe that he will be the first American engineering professor both to lecture and attend a technical meeting in the Soviet Union since World War II. Groups of American housing and farm experts have journeyed through Russia, but visits by individual technical experts have been rare.

Don A. Fischer, acting dean of the school of engineering, Washington University, St. Louis, Mo., for the past year and a half, has been named dean, and Gustav Mesmer, professor of applied mechanics and head of that department, will become director of the Edwin Henry Sever Institute of Technology.

New ASEE Award in Research Honors Curtis W. McGraw

A new award in engineering education, to recognize the research potential and accomplishment of young workers engaged in engineering research in a college or university, will be given for the first time in June, 1957.

The Engineering College Research Council of the American Society for Engineering Education recently announced plans for the Curtis W. McGraw Research Award, established in memory of the late Curtis W. McGraw, president of the McGraw-Hill Publishing Company from February, 1950, to September, 1953, and brother of the present president, Donald C. McGraw. The award, sponsored by the McGraw-Hill Book Company, will include a cash prize of $1000 and will be given annually beginning June, 1957.

Candidates are to be young men "who have made original contribution in engineering research and who have demonstrated high potential for future leadership."

In announcing the new award, Raymond J. Woodrow of Princeton University, chairman of the Engineering College Research Council, pointed out that it is the second major award in engineering college research administered by ASEE through the Council. The Vincent Bendix Research Award, for contributions to the development of research activities and their management, was first made in June, 1956, to Clifford C. Furnas, Mem. ASME, Chancellor of the University of Buffalo and Assistant Secretary of Defense for Research and Development.

"The development of these two awards," said Dr. Woodrow, "serves to emphasize the growing importance of basic research as a part of engineering education. Both teachers and their students benefit from their participation in active research undertakings on their campuses. Indeed," declared Dr. Woodrow, "this kind of research is our best assurance that today's engineering students will graduate well equipped to meet tomorrow's needs."

The recipient of the McGraw Research Award will be selected each year by a special committee of the Engineering College Research Council; Dean James R. Cudworth of the University of Alabama is chairman of this year's selection committee.

The first presentation of the McGraw Research Award will be at the 1957 ASEE annual meeting, at Cornell University, Ithaca, N. Y., from June 17 to 21. Nominations for 1957 should reach Dean Cudworth by Feb. 1, 1957.

Coming Meetings

Plastics

"Fifteen Years of Plastics Progress" will be the theme of the 13th annual national technical conference of The Society of Plastics Engineers, Inc., at the Sheraton-Jefferson Hotel, St. Louis, Mo., Jan. 16–18, 1957.

Raymond R. Tucker, Mem. ASME, and Mayor of St. Louis, will be guest speaker at the Wednesday luncheon. Technical sessions will be held morning and afternoon on Wednesday and Thursday, and also on Friday morning, with three separate meetings in each session period on the latest technical developments in a particular field. A research session will be held Thursday afternoon with the educational session scheduled for Friday morning.

Solar Furnaces

The Association for Applied Solar Energy, in conjunction with Stanford Research Institute, Arizona State College at Tempe, and the University of Arizona, will sponsor a two-day symposium on solar furnace design and operation at the Hotel Westward Ho, Phoenix, Jan. 21–22, 1957. It is being organized to bring American industries and governmental agencies the latest information on the part solar furnaces—which permit temperatures above 3000 C without contaminating influences—will be playing in the study of materials.

Dr. C. C. Furnas, Assistant Secretary of Defense for Research and Development and Chancellor of the University of Buffalo, will address the group on Monday evening. Three technical sessions are to be held: "Design and Operation of Large Solar Furnaces," "Small Solar Furnaces for Basic and Applied Research" and "Furnace Performance Deter-

mination and Control." As part of the program, symposium delegates will visit the solar furnace at Arizona State College on January 22.

Arrangements are being made through John I. Yellott, secretary of the association, 3424 N. Central Avenue, Phoenix, Ariz.

International Management Congress

On June 24–28, 1957, the eleventh International Management Congress will be held in Paris, France, under the auspices of the International Committee for Scientific Management, of which CIPM—the Council for International Progress in Management—is the American member.

Of special interest to the Congress delegates will be addresses by Henry Luce, editor-in-chief of Time Incorporated, and by Lyndall Urwick, chairman of the British management consulting firm of Urwick, Orr & Partners, and one of the leading management thinkers and authors of the world. Management specialists from 27 countries will meet at the Congress to exchange ideas on topics of current importance. From the United States, John Diebold of John Diebold & Associates will present an international report on the latest developments in the field of automation, and Melvin Hurni of the General Electric Company will report on operations research. Executives from Western Europe will present papers on the dissemination of top-management principles and techniques, public administration, the role of market research, and several other subjects.

The Council is organizing a tour for United States delegates attending the Congress. A series of shipboard management conferences has been planned on the SS *Flandre*, leaving New York, N. Y., on June 15. Peter Drucker will lead discussions of the American papers to be presented at the Congress and of some of the major questions that will face American managers in the next 20 years.

Those interested in further information on the Congress should get in touch with Colonel Philip Garey, vice-president in charge of operations, CIPM, 350 Madison Avenue, New York 17, N. Y.

Hot Lab Boon to SRI Nuclear Aircraft Propulsion Program

The hottest "hot lab" in the world was completed at Southwest Research Institute, San Antonio, Texas, November, 1956.

The $625,000 facility will be used to determine the effect of radiation on hydrocarbon materials for Pratt and Whitney as a part of their nuclear aircraft propulsion program. Harold A. Vagtborg, Mem. ASME, president of the not-for-profit research institute, said that every safety factor and precaution has been incorporated in the plans.

Aviation Research Laboratory

Covering 11,110 sq ft, the large aviation research laboratory is constructed of reddish Holland brick, concrete blocks, and plaster. In addition to two hot cells designed to handle 100,000 curies of cobalt each, the laboratory contains extensive facilities for engines, fuels, and lubricants research. Included are two bench test laboratories for subjecting fuels and lubricants to stresses simulating those encountered in aircraft of the present and the future. Larger equipment such as gear and bearing machines containing components from actual engines will be installed in ten test cells. The research is sponsored by the military and industry.

The building has offices, a drafting room, reception lobby with a reflecting pool, and a large conference room with a viewing window of the hot lab.

Al Hundere, chairman of Southwest Research Institute's Aviation Department, will be in charge of the laboratory. John M. Clark, Jr., is manager of the radiation-effects section and will be responsible for the hot lab.

The Hot Lab

The hot lab was erected for Pratt and Whitney's research on radiation effects of gamma rays and was equipped by that corporation. It contains multikilocuries of powerful Cobalt 60. (The exact radiation level of the hot cell, which is the hottest ever to be constructed, is classified at the present time.)

The hot cell is housed within massive walls of magnetite concrete to shield the radiation. Crushed iron ore was used as the aggregate and special high-density ore was shipped in from Utah.

The concrete and iron was specially compounded under the direction of Southwest Research Institute scientists. The outer walls shielding the hot cell consist of a foot of concrete, six feet of earth, and a second one-foot liner of concrete. The roof is made of five feet of concrete. The entire hot cell area is restricted and dosimeters, radiation detecting devices, will be used to keep a constant check on personnel exposure to radiation as a precautionary measure.

Scientists will look through a zinc-bromide viewing window to observe the operation of the cell. The viewing window consists of a tank filled with high-density zinc-bromide solution, faced on the radiation side with a three-inch slab of glass and laminated plate glass on the viewer's side.

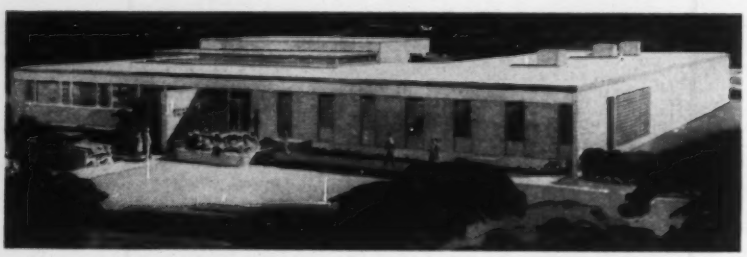
Detailed operations within the cell will be made with a pair of Master Slave Manipulators, "mechanical hands" so sensitive that they can perform as competently as human hands.

The entire installation will be inspected by the U. S. Atomic Energy Commission for safety and the Cobalt 60 will be shipped to San Antonio from Oak Ridge, Tenn.

The hot lab was completed in late November and went into operation at the end of the month. Completion of the entire aviation research laboratory is scheduled in April, 1957.

This is the second large engines, fuels, and lubricants laboratory to be built in 1956 at the San Antonio industrial research center. Ground breaking for a three-quarter-of-a-million-dollar laboratory to develop fuels and lubricants of the future for the U. S. Army Ordnance Corps was held in July.

The new aviation research laboratory will be completely air conditioned and located parallel to the Automotive Road Test Laboratory, largest research facility in the country designed exclusively for research, development, and evaluation of automotive petroleum products using automotive vehicles as research tools.



Southwest Research Institute's recently completed hot lab in San Antonio, Texas. SRI claims this latest addition to its Aviation Department is the hottest hot lab in the world.

Literature

Industrial Atomic Energy

The "AEC Experimental Program on Reactor Safety" by Richard H. Graham and D. Glenn Boyer is one of a series of monographs issued by the Atomic Energy Commission to encourage industrial interest in atomic energy. Brief discussions are given concerning the five reactor concepts of a heterogeneous test facility, SPERT (Special Power Excursion Reactor Tests), at the National Reactor Testing Station in Idaho, and the three proposals of a small

homogeneous test facility, KEWB (Kinetic Experiments on Water Boilers), at North American Aviation, Inc., Santa Susana, Cal. Brief summaries are also presented on the research objectives and statuses of fuse development, molten metal-water reactions, container tests, and fuel-igniton studies. Available from the Office of Technical Services, Department of Commerce, Washington 25, D. C., at 15 cents a copy.

Air Pollution Instruments

The 2nd edition of "Instruments for the Study of Atmospheric Pollution," published by the ASME Committee on Air Pollution Controls, is an enlarged source list for such instruments and is divided into two sections. The first is an outline of the instruments used for the study of air pollution, based on use and type. It is numerically keyed to the second portion which is an alphabetical list of 207 manufacturing suppliers. Principal headings in the first section are: Smoke density; particulate matter devices for sampling gases, vapors, and liquids; meteorological equipment and other equipment. Available from the Order Department, The American Society of Mechanical Engineers, 29 West 39th St., N. Y. 18, N. Y., at $2 a copy.

Oil and Gas Power

The "1955 Report on Oil and Gas Engine Power Costs," published by the ASME subcommittee on that subject, contains operating-cost data from 124 oil and gas-engine generating plants in the United States, with comparisons for the intervening years beginning with 1929. Copies may be obtained for $2.50 by writing to the Order Department, The American Society of Mechanical Engineers, 29 West 39th Street, New York 18, N. Y.

Design Engineering

"Design Engineering," a discussion of training in value analysis, selection of engineering materials, miniaturization trends, and recognition and rewards for inventors, is a compilation of the comment and papers presented at the Design Engineering Conference held at Convention Hall, Philadelphia, Pa., May 14–17. The Conference was born of the joint efforts of the division, the editors of four design magazines who each arranged a particular session, and Clapp & Poliak, Inc., the management for the Design Engineering Show with which it was held in conjunction. Copies may be obtained for $3.50 by writing to the Order Department, The American Society of Mechanical Engineers, 29 West 39th Street, New York 18, N. Y.

Consulting Practice

A "Manual of Consulting Practice for Mechanical Engineers," intended to be of service not only to the profession, but to clients, provides the information necessary to safeguard the interests of both. It sets forth the proper approach in obtaining professional engineering services, in establishing the fundamental structure for engineering agreements, and the general conditions that should apply to the conduct of engineering agreements. Prepared by The Committee on Professional Practice of Consulting Engineering, it is available from the Order Department, The American Society of Mechanical Engineers, 29 West 39th Street, New York 18, N. Y., at $1.50 a copy.

Bureau of Standards Publications

Inclusion of a list of depository libraries makes the "Supplementary List of Publications of the National Bureau of Standards" not only a handy ordering catalog, but a useful bibliographic tool. Published to accompany NBS Circular 460 and its Printed Supplement 7-1-47 to 6-30-52, it may be obtained from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

Older Workers

A series of studies on the older worker has been conducted by the Department of Labor and published by the Bureau of Labor Statistics, Bureau of Employment Security, and Women's Bureau. Bulletin No. 1203, September, 1956, is "Job Performance and Age" and costs 45 cents. Bulletin No. 1199 on "Older Workers Under Collective Bargaining" is in two parts costing 25 cents each. Part I, September 1956, is on "Hiring, Retention, Job Termination," and Part II, October, 1956, on "Health and Insurance Plans, Pension Plans." Bulletin BES No. E150, September, 1956, is "Pension Costs in Relation to the Hiring of Older Workers" and costs 25 cents. Bulletin BES No. E152, September, 1956, "Counseling and Placement Services for Older Workers" costs 50 cents. "How to Conduct an Earning Opportunities Forum in Your Community," leaflet 25 of the Women's Bureau, costs 15 cents. All are available from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

Manpower and Education

THE United States is now facing a manpower shortage, particularly in the fields in which exceptional talent and special training are at a premium. What will the demands be, how are they to be met, what is the significance of the manpower situation for education? These questions are the framework of *Manpower and Education*, a recent statement of the Educational Policies Commission.

In an economy such as the United States has developed a premium is put upon trained manpower. In the years immediately ahead the nation is faced with numerical shortages in the productive age group as well as general shortages of well-trained persons of high ability. Education will make a major contribution to the solution of the manpower problem.

Manpower and Education brings together widely scattered information and relates it to educational needs and trends. Part 1 of the report reviews the factors contributing to the present manpower shortages, identifies the areas in which shortages will be acute, and appraises the nation's under-used resources of manpower which may, through increased education and training, relieve the problems in the shortage areas. Population changes, the demands of national security, and the advance of technology are among the factors identified as contributing to the manpower problem. Areas of acute shortage which are identified include scientific research, engineering, education, health services, semiprofessional and technical occupations, and executive and supervisory levels in many occupations.

Part 2 of the report points to the need for consideration of democratic values in the determination of manpower policy. The right and responsibility of the individual to make his own career plans and decisions are inherent in an acceptable manpower policy. Individual values as well as ultimate national needs must be considered in reacting to manpower demands.

The implications for education at all levels are discussed in Part 3. The recommendations apply to schools, colleges, and to agencies for adult education. The commission points out the need for continued, general upgrading of the entire labor force. Policy recommendations are concerned with programs for general and vocational education, strengthening guidance and personnel services, increased efforts toward the education of the gifted, and obtaining enough qualified teachers.

Among the commission's major recommendations are the following:

1 *Continued, general upgrading of the entire labor force.* "The present high level of education on which current technological advance is founded must continue to rise. There must be more effective education, for more and more people."

2 *Education of the gifted.* "All young people, including the particularly gifted, should be educated to the highest level of their abilities. Gifted pupils should be identified early and given opportunities which will challenge their powers and develop their talents to the fullest. They should be motivated to be genuine achievers, imbued with a sense of responsibility for the wise and socially profitable employment of their abilities."

3 *Recruitment of qualified teachers.* "The teacher is a prime influence in producing increased manpower, particularly the kinds of manpower which are now in great demand. The recruitment of enough qualified teachers is a priority need. It is highly important to attract and retain capable teachers in the profession. Increased enrollment of college students and greater career opportunity for women, for minority groups, and for older persons augment the supply of qualified teachers. Attention, however, must be given to such fundamental improvements in educational practice as will alleviate shortages and improve educational standards."

Copies of the statement are available from National Education Association and American Association of School Administrators, Educational Policies Commission, Washington, D.C., for $1.25.

ASME News

With Notes on Society Activities and Events

E. S. Newman, *News Editor*

Future Role of Solid Fuels in an Expanding Economy Keynotes ASME-AIME Washington Meeting

Sheraton-Park Hotel headquarters for technical sessions, October 25 and 26

THE "Future Role of Solid Fuels in an Expanding Economy" was the theme of the 19th annual Joint Solid Fuels Conference, held October 25 and 26, 1956, at the Sheraton-Park Hotel, Washington, D. C.

A total of 234 engineers and their wives registered for the two-day sessions under the joint sponsorship of the Fuels Division of The American Society of Mechanical Engineers and the Coal Division of the American Institute of Mining and Metallurgical Engineers. The conference was arranged with the co-operation of the Washington, D. C., sections of both organizations. Eleven technical papers were presented at the four sessions.

Technical Sessions

From reports by the speakers, it soon became evident that any displacement of solid fuels would be more than offset by such factors as new uses of coal, recovery of ground lost to competing fuels, and the great increase in demand for energy sources.

Harry Perry, Mem. ASME, chief, Branch of Bituminous Coal Research, Bureau of Mines, Washington, D. C., outlined the nature and timing of the competition to be expected from nuclear materials in the paper, "Impact of Atomic Energy on Fossil Fuels," of which he was joint author with R. C. Dalzell, Mem. ASME, chief, Engineering Development Branch, Atomic Energy Commission.

"The use of nuclear fuels for process heating on a competitive economic basis appears to be farther from realization than generation of power, except in areas where fossil fuel costs are extremely high. The use of nuclear fuel for space heating appears to be even more remote, because of the critical size of the fuel inventory if individual heating units are contemplated. If district heating is considered as an alternative, the same limitations apply as in the case of fossil fuels used for district heating, that is, high distribution costs of the heat values."

He pointed out that nuclear propulsion of merchant ships, on the other hand, was not only feasible but immediate prototype construction was imperative, because of the rapid obsolescence of our merchant fleet. This needs replacement within the next twenty years, and nuclear-powered replacement will be postponed another 20 years if the technology is not developed in time.

Conventional aircraft will retain their economic advantage for short flights for a considerable period of time because of greater operating expenses for initial nuclear aircraft. In contrast to the potential advantages of using nuclear fuel in aircraft (longer distance of travel and greater payloads) or for submarines (no air required for combustion), he stated that no comparable advantages exist for locomotives. Large shielding is required, fixing the weight and dimensions of locomotives at approximately those prevailing.

About 1975, nuclear material will obtain the ascendancy in the United States for power generation. Dr. A. Parker of the Fuel Research Station, London, pointed out that England is already importing coal and expects 40 to 50 million tons to be replaced by nuclear materials by that year.

England is coping with her new position as a coal importer in another way, by improving industrial fuel utilization. W. A. Macfarlane, chief executive, The National Industrial Fuel Efficiency Service, reported that in the second year of operation 495 heat and power surveys had been made, with many factories showing the possibility of a 30 to 40 per cent saving. It was found that economies were possible in processes using industrial steam, as well as in steam generation.

Estimates made in other sessions varied in detail, but pointed to the inevitability of a changing situation on energy sources. The

View of the Joint Fuels banquet speakers' table shows, *left to right,* Thomas B. Nolan, director, USGS; Chester A. Reed, 1956 Percy Nicholls awardee; Felix E. Wormser, assistant secretary for mineral resources, Department of the Interior, banquet speaker; Leroy F. Deming, chairman, ASME Washington Section

At the ASME-AIME Fuels Luncheon raised speakers' table, *left to right*, are A. C. Fieldner; A. Parker; F. W. Miller, Vice-President ASME Region III, principal speaker; L. C. McCabe-luncheon chairman; W. A. Macfarlane; and W. S. Major. Mr. Miller discussed research responsibilities of the coal industry and education.

W. A. Macfarlane explains the work of the British Industrial Fuel Efficiency Service

R. M. Lundberg, Mem. ASME, stresses a point in the paper on regression analysis of coal

Harold J. Rose, Mem. ASME, gives a "rapid roundup" of European coal research

two papers presented in the final session gave specific details on "Coal as a Source of Power for the Aluminum Industry" and the "Changing Market Pattern for Solid Fuels." The first paper pointed out that the growth in the production of aluminum from 700,000 lb in 1950 to 1,600,000 lb in 1955, with an expectancy of 3 million lb in 1960, has outrun the sources of cheap hydroelectric power to which it was originally drawn. Other metallurgical producers are also attracted to cheap power, and the general economic upgrading in the TVA area has created such a demand for power that 60 per cent of TVA production is now steam-generated. Natural gas on the Gulf Coast of Texas and Texas lignite attracted some of the aluminum industry for a time, but after a 50-year absence the industry is being drawn back to its original locale, the Ohio River Valley. The chief attraction is cheap steam power in abundant quantities, since a 15 per cent spinning reserve is required, and interconnection cannot be depended upon in emergencies.

George A. Lamb, manager, Business Surveys, Pittsburgh Consolidated Coal Company, estimated that the industry could look to a four to five per cent annual increase for some years to come, after automatically checking off a 10 per cent decrease annually, until the past two years.

Joint Fuels Luncheon

Frank W. Miller, vice-president of the ASME Region III, the luncheon speaker on Thursday, reminded the conference that the time would come when coal would no longer be economically feasible. Far from predicting a shrinking future, he found it "a challenge to provide an abundance now, and be ready for the change when it comes." The industry has a great research responsibility to find new uses for coal now; but eventually fissionable, fusionable, and solar sources as well as coal would all be drawn on for energy.

He reminded engineers that a new Technical Development Committee had been established by ASME to foresee future professional divisions in the light of such developments, and to prevent unnecessary split-offs. He also reminded them of their responsibility to entertain superintendents of schools and department heads from colleges in the interest of developing better education—particularly better engineering education.

Felix E. Wormser, assistant secretary for mineral resources, Department of the Interior, Washington, D. C., in the banquet address, stated that "One of the world's great concerns today is the source of its energy tomorrow." And although he predicted a diminishing role for solid fuels, percentage-wise, it did not mean the eclipse of the coal industry. The over-all increase in energy requirements alone would raise production. The resurgence of coal in the past few years has been spectacular. Experts had predicted that this would happen since hydroelectric power, petroleum, and other sources would not be sufficient and would push coal back into the picture.

Nuclear power plants, surprisingly, may increase the use of coal, since large quantities are used in the production of fuel elements. Coal too is one of the few mineral products still on the export list. Electric power generation and coking, he stated, represent the greatest opportunity for coal's future.

He also spoke of the importance of research, and the fact that few individual companies had the necessary funds to undertake long-range programs on the scale that was needed. A complete inventory of the research work being done on coal has been made by the Bureau of Mines in co-operation with Bituminous Coal Research, the industry's research unit. The list of 209 projects is available from the Bureau. Our knowledge is still quite limited—no one knows, for example, the nature of the reaction that makes coal coke.

A complete survey of government development and research activity in solid fuels had been given in the afternoon session, with particular attention called to the Geological Survey's detailed field investigations to provide useful and practical information on coal beds of possible economic value in the United States and Alaska.

Concurrently with this program, the Survey is also preparing state-by-state revised estimates of coal reserves. These are published for 12 states, with Oklahoma next, and work in progress on Arkansas. Coking-coal reserves are also being estimated.

The Bureau of Mines has investigated several different methods of underground gasification of coal.

More detail on the methods used in British experiments on gasification was presented by Tom Hadow of the British Scientific Mission to this country, who had thoroughly familiarized himself with the technique, in the unavoidable absence of the authors of the paper.

The British view the idea, reported to be in commercial operation in Russia, as a possible means of utilizing 200 million tons of coal not available in any other way because of the thinness of seams. If it can be perfected, energy will be available for 17 cents per million Btu, compared with 47 cents for native-mined coal, and about 70 cents for imported coal.

Unfortunately, gas deteriorates in quality as gasification progresses, and seepage through fissures is another difficulty. There were also numerous complications with the equipment and methods used. A. Parker commented that the advantages of a practical method are so great that Britain has spent £$^3/_4$ million on experiments, and Belgium a like amount.

The research activities of the coal and associated industries were summarized in another paper and careful apportionment of projects appropriate to private industry, government, universities, and others was suggested. Harold J. Rose, Mem. ASME, also gave a rapid rundown of what he had seen on a tour of European research facilities. Europeans, he said, are aware of the necessity for the full range, with "a great deal of fundamental research, a great deal of bench research, and also pilot research." Several countries are building extremely well-equipped labs and 2000 people are now employed in coal research on the Continent.

Conservation of fuel was an important field of research in areas where any product with less than 72 per cent ash is considered fuel and 40 per cent ash-content fuels have been in use for a long time. There is great interest in smokeless fuels with air pollution so bad that headlights were required in Belgium at noon.

Mine safety is another field with particular interest in remote-indicating instruments that record the strain on roof bolts. Once safety limits are known, economies will result, since unreasonable margins of safety will not be

Chester A. Reed, *left,* receives the 1956 Percy Nicholls Award from J. B. Morrow

Harry Perry, Mem. ASME, tells of the impact of atomic energy on solid fuels

J. F. Barkley, *left,* Fellow ASME, and H. G. Bryan, Assoc. Mem. ASME

necessary. In Holland, liquid-filled "pancakes" costing only $2 a piece are used in recording this strain. Another Dutch contribution is a simple, compact, curved screen which is nonblinding. They have also set up a petrographic research lab right in a mine.

There is considerable briquetting in Europe particularly of the size of almonds (including the shell). High-temperature coke research is widespread, and one product of chemical research is a butyl ester useful in treating athlete's foot and a number of other skin irritations.

Several papers were presented on fuel technology, all of them concerned with methods of measuring performance. "Determination of Heat Content of Coal by Regression Analysis" was an evaluation of this method sometimes called the "least squares method" based on experiments conducted at the Northwestern University School of Commerce, Evanston, Ill., by R. L. Pasek, assistant professor there, and R. M. Lundberg, Mem. ASME, efficiency engineer, Commonwealth Edison Company, Chicago, Ill.

A combustion symposium considered the possibility of correlating ignitibility with the burning characteristics of fuel, and the use of a laboratory test as an index of combustion performance, and the final paper was on the ignitibility of fresh fuel and the reactivity of residual carbon.

Percy Nicholls Award Presentation

The banquet was the occasion for the presentation of the Percy Nicholls Award for 1956. Chester A. Reed, Mem. ASME, director of the engineering department of the National Coal Association, was the fifteenth recipient of the award presented for "outstanding achievement in the field of solid fuels."

As head of NCA's engineering department, he pioneered the first nationwide fuel engineering service in the coal industry and was active in the organization of Bituminous Coal Research, Inc., which he has served for many years as secretary and secretary-treasurer.

As director of the engineering department of NCA, he worked with the Navy Department and other branches of the government in seeking better utilization of coal in government plants, and he has represented the U. S. Government in Europe in solving postwar fuel problems on several occasions.

He spoke of his association with the late Percy Nicholls at the beginning of his own career and what that contact had meant to his interest in coal research. Born in England in 1870, Mr. Nicholls came to the United States in 1897 to begin a lifetime of work on behalf of coal in both private industry and government. At his death in 1942, he had been supervising engineer of the Fuels Section of the Central Experimental Station of the Bureau of Mines at Pittsburgh, Pa., for 19 years.

The presentation was made by J. B. Morrow, the award winner in 1944, who had been a director of NCA for ten years and has also received the Erskine Ramsay Gold Medal and the Bituminous Coal Research Award. He has been chairman and president of the Pittsburgh Coal Company and first vice-president of its successor, the Pittsburgh Consolidated Coal Company.

All sessions of the conference were held at the hotel, with technical sessions in the Continental Room, luncheon and banquet in the Burgundy Room, cocktail hour in the Caribar Room, and committee meetings in the Mural Room and Madison Suite. The latter was also the site of the authors' breakfasts, held each morning for the authors of technical papers.

Ladies' Activities

The Franklin Room was the center of the ladies' activities which included a coffee

View of group at the banquet of the 19th annual Joint ASME-AIME Solid Fuels Conference

Some of the participants in the women's activities at the conference

hour both mornings. The room also served as a gathering point for the special tours arranged by Mrs. A. Wiley Sherwood, chairman of the committee on ladies' activities. The tours included Rock Creek Park which was displaying fall foliage, and a viewing of the various embassies. On the second day, the women were the guests of the Pakistan Embassy for a special tea in their honor.

They also had a general tour of Washington, including Georgetown, Arlington National Cemetery, the Lee Mansion, Lincoln Memorial, and the Episcopal Cathedral. Luncheon on the first day was at Normandy Farms, and on the second day it was combined with a fashion show at the Sheraton-Carlton Hotel.

Availability List for 1956 ASME Fuels Division Conference Papers

The papers in these lists are available in separate copy form until July 1, 1957. Please order only by paper numbers; otherwise the order will be returned. Copies of these papers (25 cents to members; 50 cents to nonmembers) may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y.

Paper No.	Title and Author
56—FU-1	Fly-Ash Refiring, by W. W. MAULL and E. C. MCMAHON
56—FU-2	Ignitibility Testing as a Measure of the Burning Characteristics of Solid Fuels, by H. W. NELSON and J. M. PILCHER
56—FU-3	Industrial Fuel Utilization in the United Kingdom, by W. A. MACFARLANE
56—FU-4	Determination of Heat Content of Coal by Regression Analysis, by R. L. PASEK and R. M. LUNDBERG
56—FU-5	Progress Report—Ignitibility of Fuels and Burning Rates of Fixed Carbon, by N. D. PHILLIPS
56—FU-6	An Effort to Use a Laboratory Test as an Index of Combustion Performance, by F. J. CEELY and R. I. WHEATER
56—FU-7	Impact of Atomic Energy on Fossil Fuels, by R. C. DALZELL and HARRY PERRY

Combustion Control Conference at Norwich, Conn., by ASME Region I

THE attendance totaled 236 at the Region I Conference on Combustion Control held at the Norwich Inn, Norwich, Conn., October 19.

Notables in Attendance

Not only the president-elect of The American Society of Mechanical Engineers, W. F. Ryan, but also two past-presidents, E. G. Bailey and E. W. O'Brien, were present. The chairman of the dinner portion of the meeting was Dean Van Vleck of the Harvard Engineering School and dinner speakers were Dr. Bailey and Lieutenant-Governor Jewett of the State of Connecticut.

Paul V. Stevens, Mem. ASME and assistant plant superintendent, Montaup Electric Company, Fall River, Mass., was chairman of the technical session which followed the dinner. S. C. Leland, Mem. ASME, and of the Mechanical Division, Stone & Webster Engineering Corporation, Boston, Mass., opened the technical session with a paper entitled "Application of Combustion Controls."

The presentation by Mr. Leland was followed by a symposium on operating experiences with combustion controls, which included reports by 17 individuals active in this field. The technical session was especially well received and the papers presented showed evidence of careful preparation.

Plant Tours

As part of the meeting, open house with plant tours was held by the Montville Station of the Connecticut Light and Power Company, the Middletown Station of the Hartford Electric Light Company, and the Groton plant of Charles Pfizer and Company.

E. G. Bailey Principal Speaker

E. G. Bailey, past-president and Fellow ASME, spoke on the fundamentals of combustion control at the dinner. "The basic requirement," he stated, "for combustion control applied to a steam boiler is to control heat from the combustion of fuel with air in correct proportion to the demand for steam at any given instant." Each factor involved must be accurately measured as a preliminary to automatic control.

Technical Symposium

S. C. Leland, Mem. ASME and Stone & Webster engineer, introduced the technical symposium, pointing out that "60 years ago nearly all boilers were fired with a shovel" but after 1900 "increased capacities and capabilities for rapid load change responses exceeded the limit of human operator endurance," and today nearly all large boilers, and many small ones, are automatic.

Details of several systems of control for oil, pulverized coal, and gas as well as coal-fired boilers were outlined by the speakers. Information on maintenance, operator training, and other practical problems derived from operating experience was also presented.

Much of the credit for the success of the conference, particularly for the large turnout, goes to Edmund McCarthy, consulting engineer, Pocahontas Fuel Company, Inc., Salem, Mass., and a member of the Attendance Committee.

Principals at the session Conference on Combustion Control dinner, *left to right*, are Dean Van Vleck, Harvard Engineering School and chairman of the dinner session; Lieutenant-Governor C. W. Jewett of the State of Connecticut, and E. G. Bailey, the speaker

ASME Presidents at the Region I Conference on Combustion Control held at the Norwich Inn, Norwich, Conn., October 19. *Left to Right* are past-presidents E. W. O'Brien and E. G. Bailey; and president-elect W. F. Ryan

1956 Lubrication Conference Planning Committee shown front row, *left to right*, are R. B. Purdy, H. A. Hartung, F. W. Ocvirk, A. C. West, and S. Abramovitz. Back row, *usual order*, are Ernest Rabinowicz, E. E. Bisson, and A. E. Cichelli.

Registrants at the ASME-ASLE Lubrication Conference, Atlantic City, N. J., Oct. 8–10, 1956, await pocket identification card and packet of conference papers being passed out by H. A. Hartung, shown to the *left*

Third ASME-ASLE Lubrication Conference Attracts 400 Engineers

THE third Lubrication Conference jointly sponsored by The American Society of Mechanical Engineers and the American Society of Lubrication Engineers, held at Atlantic City, N. J., October 8, 9, and 10 was the most outstandingly successful of the three Conferences that have been held. Attracted by the high-caliber research papers, 400 engineers attended the Conference. This attendance far exceeded the attendance at the two previous meetings.

Special interest was taken in the two sessions devoted to bearing and lubricant problems in nuclear-power plants. Of the five papers presented, three dealt with the effects of radiation on lubricants and bearing materials.

Also great interest was taken in the "Reporter Session" at which 13 papers dealing with hydrodynamic lubrication were presented. This session was divided into two parts. E. F. Macks reported half of the papers and discussion of them followed immediately. D. D. Fuller reported the remainder. The Reporter Session was well organized and went smoothly. Its success was indicated by the active discussion in which 24 engineers participated.

This European method of paper presentation has proved to be an effective way of providing for a maximum amount of discussion on a related subject.

The procedure was as follows:

1 A "reporter" presented a brief summary of each paper. The papers were not presented by the authors.

2 After each summary was presented, the floor was open for discussion.

3 The last portion of the session was set aside for authors' comments and closures.

Papers presented at the other sessions dealing with wear, boundary lubrication, solid-film lubricants, fretting, and lubricants were also well received.

Plans for the fourth joint ASLE-ASME Conference at Toronto, Ont., Canada, October 7, 8, and 9, 1957, are already under way. The 1957 Conference Planning Committee under the chairmanship of E. E. Bisson has held its first meeting at which the following appointments were made: Papers Co-ordinator, H. A. Hartung; Session Organizers, R. A. Rabinowicz, E. G. Jackson, Al Hundere, A. C. West, and F. R. Archibald; and Secretary and Publicity, R. B. Purdy.

Availability List of Papers for 1956 ASME Lubrication Conference

The papers in these lists are available in separate copy form until July 7, 1957. Please order only by paper numbers; otherwise the order will be returned. Copies of these papers (25 cents to members; 50 cents to nonmembers) may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y.

Paper No.	*Title and Author*
56—LUB-1	On the Theory of Grease-Lubricated Thrust Bearings, by A. SLIBAR and P. R. PASLAY
56—LUB-2	Analysis of Journal Bearings With Arbitrary Load Vector, by O. PINKUS
56—LUB-3	Testing Dynamically Loaded Bearings—1 A Short History of Bearing-Test Machines, by M. D. HERSEY and R. B. SNAPP
56—LUB-4	Testing Dynamically Loaded Bearings—2 A Diesel-Engine Bearing-Test Machine, by R. B. SNAPP and M. D. HERSEY
56—LUB-5	Surface Roughness—A Criterion for Minimum Hydrodynamic Oil-Film Thickness of Short Journal Bearings, by L. F. KREISLE
56—LUB-6	The Fluid Dynamic Theory of Gas-Lubricated Bearings, by J. S. AUSMAN
56—LUB-7	Properties of Misaligned Journal Bearings, by G. B. DU BOIS, F. W. OCVIRK, and R. L. WEHE
56—LUB-8	Experiments on Gas-Lubricated Journal Bearings, by M. WILDMANN
56—LUB-9	Universal Bearing Tester, by R. J. S. PIGOTT and B. R. WALSH
56—LUB-10	Statistical Analysis of a Wear Process, by B. G. RIGHTMIRE
56—LUB-11	Heat-Transfer Effects in Hydrostatic Thrust-Bearing Lubrication, by W. F. HUGHES and J. F. OSTERLE

1957 ASME Tours

Puerto Rico in April

Puerto Rico and Virgin Islands from Birmingham, Ala., or New York, N. Y., April 10 to 15 *or* 20, 1957, following the Spring Meeting, April 8–10.

Hawaii in June

Hawaiian and the Outer Islands, leaving from San Francisco, Calif., June 14, returning 24 *or* 29, 1957, following the Semi-Annual Meeting, June 9–13.

Complete information upon request addressed to
ASME Headquarters, 29 West 39th Street, New York 18, N. Y.

Lead walls and doors up to eight inches thick, line the vault from which delicate scintillators picked up signals from neutrons—if they exist. The scintillators are similar to those used by uranium prospectors but a million times as big and powerful.

Members of the research team which discovered the neutrino at the Savannah River Plant of the AEC. *Left to right,* kneeling, R. P. Jones, F. W. Rice, and H. W. Kruse; standing, C. L. Cowan, Jr., F. B. Harrison, A. D. McGuire, Frederick Reines, and M. P. Warren.

Neutrino Discoverer Addresses Savannah River Section

The Central Savannah River Area Section of The American Society of Mechanical Engineers had Frederick Reines of the Los Alamos scientific laboratory as guest speaker for the opening meeting of the 1956–1957 season.

Dr. Reines together with Clyde L. Cowan headed the team whose discovery of the neutrino was announced on June 21, 1956, by simultaneous news releases from the Atomic Energy Commission's offices at Washington, D. C., Savannah River Plant, and Los Alamos, N. Mex.

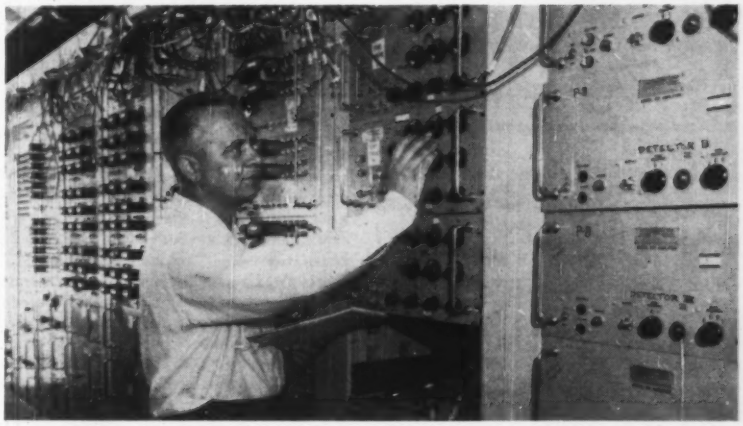
Nobel Laureates Enrico Fermi and Wolfgang Pauli theorized that such a particle existed and that it would account for the mysterious disappearance of energy from a radioactive process known as Beta decay. This was necessary to substantiate the universally accepted principle of the conservation of energy, which holds that energy can neither be created nor destroyed.

Dr. Reines' talk was primarily on the novel problems experienced in developing equipment and instruments for the experiments at the Savannah River Plant operated by du Pont for the Atomic Energy Commission, which led to the discovery of the neutrino. A key part of the equipment is a bank of scintillation detectors, similar to those used by uranium prospectors, but a million times as big and powerful.

The neutrino's discovery will provide a new tool for physics and for scientific research in such fields as the origin of the universe, the energy cycle of the sun and stars, and the structure of elementary particles.

Although this was pure research, unanticipated economic value resulted. The instruments developed are already being employed in medical research and have saved amounts comparable to the cost of the primary program.

Photomultiplier, one of 418, used in the seintillation detector to relay signals



Monitoring equipment in van which receives signals relayed by detector tubes is checked by Clyde L. Cowan, Jr.

ASME Coming Events

March 10–15, 1957
Nuclear Congress, Convention Hall, Philadelphia, Pa.
(Final date for submitting paper was Nov. 1, 1956)

March 18–21, 1957
ASME Gas Turbine Power Conference, Hotel Sheraton-Cadillac, Detroit, Mich.
(Final date for submitting papers was Nov. 1, 1956)

March 27–28, 1957
ASME Engineering Management Conference, Hotel William Penn, Pittsburgh, Pa.
(Final date for submitting papers was Nov. 1, 1956)

April 8–10, 1957
ASME Spring Meeting, Hotel Dinkler-Tutwiler, Birmingham, Ala.
(Final date for submitting papers was Dec. 1, 1956)

April 22–24, 1957
ASME Instruments and Regulators Conference, Northwestern University, Chicago, Ill.
(Final date for submitting papers was Dec. 1, 19 6)

April 25–26, 1957
ASME Railroad Conference, Hotel Sheraton, Chicago, Ill.
(Final date for submitting papers was Dec. 1, 1956)

April 25–26, 1957
ASME-SAM Management Conference, Hotel Statler, New York, N. Y.
(Final date for submitting papers was Dec. 1, 1956)

May 16–17, 1957
ASME Wood Industries Conference, Winston-Salem, N. C.
(Final date for submitting papers—Jan. 1, 1957)

May 19–23, 1957
ASME Oil & Gas Power Conference, Kentucky Hotel, Louisville, Ky.
(Final date for submitting papers—Jan. 1, 1957)

May 20–23, 1957
ASME Design Engineering Conference, Coliseum, New York, N. Y.
(Final date for submitting papers—Jan. 1, 1957)

June 9–13, 1957
ASME Semi-Annual Meeting, Sheraton-Palace Hotel, San Francisco, Calif.
(Final date for submitting papers—Feb. 1, 1957)

June 13–15
ASME Applied Mechanics Conference, University of California, Berkeley, Calif.
(Final date for submitting papers—Feb. 1, 1957)

August 11–15
ASME Heat Transfer Conference, Pennsylvania State University, University Park, Pa.
(Final date for submitting papers—April 1, 1957)

Sept. 9–13
ASME IRD-ISA Conference, Auditorium, Cleveland, Ohio
(Final date for submitting papers—May 1, 1957)

Sept. 22–25
ASME Petroleum Mechanical-Engineering Conference, Hotel Mayo, Tulsa, Okla.
(Final date for submitting papers—May 1, 1957)

Sept. 23–25, 1957
ASME Fall Meeting, Hotel Statler, Hartford, Conn.
(Final date for submitting papers—May 1, 195)

Oct. 7–9, 1957
ASLE-ASME Lubrication Conference, concurrently with ASME-IMechE International Conference on Lubrication and Wear, Royal York Hotel, Toronto, Ont., Canada
(Final date for submitting papers—June 1, 1957)

Oct. 8–12, 1957
ASME-AIME Fuels Conference, Chateau Frontenac, Quebec, Que., Can.
(Final date for submitting papers—June 1, 1957)

Dec. 1–6, 1957
ASME Annual Meeting, Hotel Statler, New York, N. Y.
(Final date for submitting papers—July 1, 1957)

Meetings of Other Societies

Dec. 17
Institute of the Aeronautical Sciences, Wright Brothers lecture, Chamber of Commerce, Washington, D. C.

Dec. 26–31
American Association for the Advancement of Science, national meeting, Statler, Governor Clinton, and McAlpin Hotels, New York, N. Y.

Jan. 14–16, 1957
The Institute of Radio Engineers, The American Society for Quality Control, The Radio-Electronic Television Manufacturers Association Engineering Department, The American Institute of Electrical Engineers, 3rd national symposium on reliability and quality control in electronics, Hotel Statler, Washington, D. C.

ASME Elects Fellows

THE American Society of Mechanical Engineers has honored ten of its members by electing them to the grade of Fellow of the Society.

To be qualified as a nominee to the grade of Fellow one must be an engineer with acknowledged engineering attainment, have 25 years of active practice in the profession of engineering or teaching of engineering in a school of accepted standing, and be a member of the Society for 13 years. Promotion to the grade of Fellow is made only on nomination by five Fellows or members of the Society to the Council, to be approved by Council.

The men who were so honored for their outstanding contributions to their profession and to the Society are:

Charles W. Crawford

CHARLES WILLIAM CRAWFORD, associated with A&M College of Texas, College Station, Texas, since 1919 and appointed professor of mechanical engineering in 1928, and head of the mechanical-engineering department the following year, has an outstanding record in the field of engineering, although his reputation is largely confined to the Southwest. He has devoted his time to building a department—the teaching staff now numbers more than 30 men—and planning programs for undergraduate and graduate students in mechanical engineering. He has devoted much time to the preparation of the student at the freshman and sophomore level in college to make the student's later work more effective. He began the preparation of a "Problems in Engineering" course shortly after becoming head of the department, and to aid in this work prepared a text on "Introductory Problems in Engineering," which was first published in 1931 and had its fourth revision in 1949. Although he has been Chairman of the South Texas Section of The ASME and has served well on the Section Delegates Conferences, he has concentrated his ASME activity on promoting the interests of students in ASME, and in maintaining contact with mechanical-engineering graduates to encourage them to become active in ASME. He received a Certificate of Commendation last year from the South Texas Section of ASME for his outstanding work in that area. He has been a Mem. ASME since 1931.

Raymond C. Dannettel

RAYMOND CHARLES DANNETTEL, senior engineer, Baltimore Gas and Electric Company, Baltimore, Md., has been a member of the engineering staff of that company since 1923 and was cited for his contribution to the advancement of power generation and the dissemination of information on steam turbines and their applications. Among the projects for which he has been responsible are major units of his company's installations at Westport, Riverside, Gould Street, and Wagner generating stations which have more than doubled the company's generating capacity. He has worked closely with A. L. Penniman, Jr., Honorary Mem. ASME, and vice-president of the company, on The ASME Special Standards Committee on Steam Turbines since its inception in 1943. Mr. Penniman has been vice-chairman and is now chairman of that committee which prepared the existing Preferred Standards for 3600-rpm Condensing Steam Turbine Generators in conjunction with a committee of the American Institute of Electrical Engineers. Mr. Dannettel became a Mem. ASME in 1924 and is also a member of the National Society of Professional Engineers, Maryland Society of Professional Engineers, and the Engineers Club of Baltimore. He has had a responsible part in the accumulation of information and preparation of reports for the Prime Movers Committee of the NELA. As a deputy of Mr. Penniman, with full latitude for independent action, he has made significant contributions to Supervisory Committee No. 5 on Steam Turbines of the U. S. National Committee of the International Electro-Technical Commission and on various sectional committees of the American Standards Association which have been actively interested in the preparation of the Code for Pressure Piping, Standardization of Pipe Flanges and Fittings, Standardization of Materials and Dimensions of Wrought Iron and Wrought Steel Pipe, and similar matters.

Arthur S. Hawks

ARTHUR STEARNS HAWKS, a pioneer and leading authority on internal-combustion engines, particularly diesel engines, who retired from the U. S. Navy after World War II, began his career with a gold placer mining company in Virginia City, Mont. This was followed by a varied shop and engineering experience with builders of steam and gas engines prior to going with the Bethlehem Steel Company, Bethlehem, Pa., in 1908. At Bethlehem Steel he was in charge of the design of double-acting gas engines, considered the forerunner of the diesel. During World War I, he was responsible for the design and development of a series of high-speed lightweight diesel engines for submarines. These were among the first two-cycle diesel engines for submarines to be designed and built in the United States. The Busch-

Sulzer Brothers, St. Louis, Mo., for whom he was then chief engineer, brought out a new line of heavy-duty slow-speed stationary and marine diesel engines after the war and also built 3000-hp units for converting six of the U. S. Emergency Fleet Corporations' steamships to diesel operation. These were also among the earliest engines of the type and horsepower to be made in the United States. From 1929 to 1934 he was chief engineer with Fairbanks, Morse and Company. Further development work on diesel engines for submarines was done for the Naval Engineering and Experimental Station at Annapolis, Md., from 1934 to 1936, and for the Nordberg Manufacturing Company of Milwaukee, Wis., from 1936 to 1939; and as an engineer for the U. S. Navy Bureau of Ships, from 1941 to 1946. During World War II, he acted in a consulting and advisory capacity on diesel engine design, maintenance, and operational problems for the Navy's large fleet of diesel-powered vessels. He was elected Jun. ASME in 1904 and Mem. ASME in 1909.

John H. Hitchcock

JOHN H. HITCHCOCK, chief, mechanical engineering, Morgan Construction Company, Worcester, Mass., with whom he has been associated since 1930, has obtained widespread recognition as an authority on rolling-mill engineering, particularly on the performance of roll neck bearings. In 1932, while working as research associate for the ASME special committee on Heavy-Duty Antifriction Bearings, he derived for the first time, a means of evaluating the "roll flattening" which occurs during the cold rolling of metals. This was published in Roll Neck Bearings (ASME, 1935) and has subsequently been quoted in every major publication, in foreign languages as well as in English, which related to the theory or experimental evaluation of cold rolling. Investigators (D. A. Bland, Proceedings, Inst. Mech. Engr. Appl. Mech., vol. 163, 1950) at the British Iron and Steel Research Association undertook a program intended to disprove or qualify the derived relation and later recommended its acceptance. The relation has been and is being used almost universally by engineers concerned with cold rolling. Because of his experience in evaluating the forces and power requirements for rolling, and his wide experience in the experimental and analytical evaluation of roll-neck-bearing performance, his advice has been sought by engineers from customers' plants and elsewhere as well as by his own associates. Major decisions on numerous important rolling-mill projects have been based on his recommendations in this regard. Elected an Assoc-Mem. ASME in 1931, Mem. ASME, 1937, he has been a member of the ASME Research Committee on Plastic Flow of Metals since 1935 and chairman since 1953; and a member of the ASME Research Executive Committee since 1954. He also serves on the ASLE Bearing Research Committee, the AGMA Gerr Rating Co-ordinating Committee, and the Mill Gearing and Bevel Gear Committees of that organization. A member of the ASM and AISE, and past-president of the Worcester Engineering Society, he has also delivered a number of addresses on engineering subjects, particularly before engineering student groups at Worcester Polytechnic Institute.

Waldemar Kaempffert

WALDEMAR KAEMPFFERT, science editor of the *New York Times*. For more than half a century, he has popularized scientific ideas, their commercial application, and social significance. He has particularly emphasized that the scientist is "molding new worlds which will present new problems to men and governments." His reports on medical progress, published in the *New York Times*, won a special Albert Lasker citation for medical journalism; and in 1954 his "distinguished career in science writing" was honored by UNESCO with the award of the Kalinga prize, one of the world's highest scientific honors. He began as a translator of science and engineering articles on the staff of the *Scientific American*, advancing to managing editor. After serving as editor of *Popular Science Monthly*, he was director of engineering service for Thomas F. Logan, Inc., where his duties were to advise clients on the proper presentation of engineering subjects in their advertising campaigns. As science and technical editor of the *New York Times* in 1927 and 1928, he wrote editorials and signed Sunday articles on scientific and engineering subjects, leaving after a period to become director of the Chicago Museum of Science and Industry founded by Julius Rosenwald, and then in its formative stages. The largest technical museum in this country, it is modeled after the Science Museum of South Kensington, the Conservatoire des Arts et Metiers, and the Deutsches Museum of Munich, with over 400,000 sq ft of science and engineering exhibits, most of them in operation. In 1931, he returned to The *Times* as science editor. Mem. ASME since 1930, he is also a member of the AAAS, author of numbers of books on science and technology, and contributor of numerous articles to the principal popular magazines in America and Europe. One of the organizers of the National Association of Science Writers, he served as president of that organization in 1937. A native New Yorker, he received a BS from CCNY in 1897 and, while writing about science, studied law intending to become a patent lawyer. He received his law degree from NYU in 1904 and was admitted to the bar, but writing had more appeal. Clarkson Polytechnic Institute awarded him an Hon. DS in 1939.

Clarence E. Pond

CLARENCE EDWARDS POND, general superintendent of motive power, Norfolk and Western Railway Company, Roanoke, Va. Mem. ASME since 1942. In addition to his railway responsibilities he has served as chairman of the Virginia Section, ASME, 1947-1948, and chairman of the Railroad Division, ASME, 1951. He has also served as chairman of the Committee on Terminal Facilities, Steam Locomotive Maintenance Officers Association, 1948, 1949, and 1950, and president, Southwestern Virginia Engineers Club, 1949–1950. He has prepared and presented a number of technical papers pertaining to the maintenance, performance, and design of modern coal-turning steam locomotives before the ASME and other organizations. He had over-all supervision of the building of the Norfolk and Western's steam turbine-electric locomotive No. 2300 and follows the Railway's interest in the coal-fired gas-turbine project under development at Dunkirk, N. Y. He served as chairman of AAR Co-ordinating Committee on Physical Research in 1956. He is currently serving as chairman of AAR General Committee.

R. Tom Sawyer

ROBERT THOMAS SAWYER, formerly manager of the research department of the American Locomotive Company, New York, N. Y., and now consultant, including Alco Products, Inc., Schenectady, N. Y., Experimental Towing Tank at Stevens Institute of Technology, and the Transportation, Research, and Development Command, Fort Eustis, on the application of the gas turbine through mechanical drive to a locomotive. This is a first step toward application of nuclear power, to all forms of military transportation which are of sufficient size to make such application feasible, particularly mobile equipment. He was responsible more than any other person for the establishment of the ASME Gas Turbine Co-ordinating Committee of the Oil and Gas Power Division, which later became the Gas Turbine Power Division of the Society. He is past chairman of the Oil and Gas Power Division and is still actively associated with that division as well as with the Gas Turbine Power Division and has rendered many other services for the Society. He became an Assoc-Mem. ASME in 1930, and a Mem. ASME, 1935. His earlier work was in the field of diesel locomotion, and his publications, including books on diesel locomotives, gas turbines, and atomic-power application, represent a group of acknowledged engineering attainments. He is also a member of AIF, SAE, fellow member of AIEE, and registered professional engineer. He serves on the joint committee of the ASME and the American Rocket Society and was on the board of directors of ARS. Also he was secretary and chairman of the Technical Committee of the Steam Locomotive Research Institute (dissolved, 1952). In this work he was in charge of both design and test work in special steam locomotive development. Other memberships include DEUA, IME (London); ANS (board of directors and chairman of the Membership Committee); and The Franklin Institute, Philadelphia, Pa. (member, Science and Arts Committee).

Erwin H. Schell

ERWIN HASKELL SCHELL, Professor Emeritus and lecturer, School of Industrial Management, Massachusetts Institute of Technology, Cambridge, Mass., has made contributions to the science of engineering in the fields of engineering, administration, and industrial management on both a national and international level, and as a teacher and lecturer. He has served as a consultant for the Department of State, and on special missions to Europe. He was a U. S. delegate to the International Management Congresses at London in 1935, at

Washington in 1938, and also at Stockholm in 1948, at Brussels in 1951, and at Sao Paulo in 1954. He is author of a number of books including the "Technique of Executive Control" published in 1924, now in its eighth edition, and of many technical papers. Awarded the AISC War Medal in 1920; the Gilbreth Medal, 1938; Wallace Clark International Award, 1953; he was made an honorary counselor, Comité International de l'Organization Scientifique in 1954. Elected an Assoc-Mem. ASME in 1921, he became a Mem. ASME in 1935, and has served for many years on the Gantt Medal Board. He is also a member of the Academy of Management, American Academy of Arts and Sciences, American Management Association, and the Council for International Progress in Management.

Sherrod E. Skinner

SHERROD E. SKINNER, vice-president and group executive in charge of the accessories divisions, and member of the board of directors, Operations, Policy, and Administration Committees of General Motors Corporation, Detroit, Mich. As general manager of the Oldsmobile Division from August 5, 1940, to January 1, 1951, he carried on the design and development of the V-8 Rocket engine, Oldsmobile's postwar high-compression engine introduced in 1948 on 1949 models. Divisions under his direction since 1951 have developed a wide range of commercial and military products. During World War II (September 1, 1942, to March 1, 1943) he served as director of the Production Division, Services of Supply, War Department, with headquarters in Washington, D. C. He is a graduate and a life member of the board of trustees of Rensselaer Polytechnic Institute, a Navy veteran of World War I, and a director of the American Ordnance Association. Elected a Junior Member ASME in 1931 he became a Life Member ASME in 1952. He is also a member of Chi Phi and Sigma Xi fraternities and the Society of Automotive Engineers.

Maurice J. Zucrow

MAURICE JOSEPH ZUCROW, professor of gas turbines and jet propulsion Purdue University, is a leading American authority in the fields of gas turbine and rocket propulsion and author of an outstanding work in the field, "Jet Propulsion and Gas Turbines," and also of the section on Propulsion in "Principles of Guided Missile Design, vol. 2." He is also author of more than thirty-five technical papers, articles, and bulletins in the fields pertaining to carburetion, fluid dynamics, vibration, instrumentation, rockets, jet propulsion, gas turbines, and piston engines, and holds approximately ten patents relating to the fields of instruments, the combustion of heavy fuels in piston engines, and rocket propulsion. Important committee activities relating to national defense include membership on several subcommittees of the National Advisory Committee for Aeronautics, including chairmanship of the subcommittee on Rocket Engines, membership on the Committee on Guided Missiles of the Research and Development Board, Department of Defense. For that Department he was chairman of the Panel on Propulsion and Fuels, and a member of the Technical Consulting Group, as well as a consultant on the Aeronautical Panel, Office of Assistant Secretary of Defense for Research and Development, and consultant to the Technical Intelligence Branch of the U. S. Air Force, and the Ordnance Corps, WSPG, Department of the Army. He is also a consultant to several industrial companies working in the gas turbine, jet propulsion, and allied fields. A Mem. ASME since 1932, he is also a member of the SPEE, and a Fellow of the American Rocket Society, Sigma Xi, Pi Tau Sigma, and Tau Beta Pi. He received the Pendray Award of the American Rocket Society for his contributions to the literature on jet propulsion.

Junior Forum

Conducted for the National Junior Committee

by R. A. Cederberg,[1] Assoc. Mem. ASME

When the Engineer Becomes a Supervisor

By Lynn E. Castle[2]

YOUNG engineers sometimes express concern about their future in the profession. They want to develop, design, and test things. That is the work they most enjoy. Yet as they look around they see rewards and recognition going to engineers who have taken on supervisory duties. They fear that sooner or later they will have to choose between the professional road and the administrative road.

Usually, that is not what happens. Instead, it may be like this: The engineer starts out in a development and design job. He gets small projects and he does them well. He grows in professional experience. Bigger assignments come his way and he masters them. His reputation grows. Soon he is handling complex projects on which it is more economical for him to utilize assistants. This happens to him, not by deliberate choice of an administrative career over a professional one, but rather as a result of his very competence as a professional engineer. If he were mediocre, life would be much simpler.

Engineering Training Applied to Administration

Now the question arises, can his engineering training be applied to this new business of getting results through the work of other people? Can the engineer's way of thinking be used on such problems? Is a rational approach to human leadership possible?

If I understand the engineer's approach to an engineering assignment, it might be stated something like this:

1 He commits himself to achieve a specified result. It may be a bridge or the plan of a bridge, a building, or a circuit, but he knows precisely what it is and the function it must perform. He knows and defines quite clearly the result he is trying to accomplish.

2 He studies the materials and the forces he must manipulate to get these results and he operates on them according to their nature. He is utterly objective about the materials and the forces upon which he works.

3 He is possessed of various skills and techniques by which the materials and forces within his field may be handled to produce desired results. He perfects himself in these techniques and learns new ones as they are needed.

The Engineer as Supervisor

Now, when the engineer finds himself also a supervisor, using the work of other people as a part of his process of getting engineering results, can he apply the same rational approach?

First, can he specify the results he wants? He can show his people the technical results that they are expected to contribute and how these results fit into the over-all engineering result which he and his organization are committed to get. But to secure the kind of performance from them that will yield these results he has to provide certain human conditions which are a result in large part of the things he does in his role as a supervisor. They also can be specified.

One is an atmosphere of confidence and security in which his people come to feel they can get what they want from their jobs if they do what is expected of them. This confidence grows not only out of what the supervisor does but the manner in which he does it. Another result he must get is a feeling among his people that if they put forth effort they can improve themselves and progress. Are their ideas and suggestions about the work sought after and used? Do they have an opportunity to solve real problems? Do they have freedom to grow? These are some of the human results that the engineer sets out to get in his role as a supervisor.

The second thing about an engineer's approach is that he understands the materials

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[2] Training Supervisor, Sandia Corporation, Sandia Base, Albuquerque, N. Mex.

and forces on which he works, and deals with them objectively. He does this with stresses and protons and physical systems. Can he do it with human and organizational forces in his role as a supervisor? He must, if he is to have any degree of control over them and get predictable results. He can go about acquiring an understanding of his people in just the same way that he gains a working knowledge of the other materials and forces he must handle as an engineer. As a professional man, he knows that in any field of study, much of the layman's lore is inadequate, and that the layman's ways of looking at things, his working hypotheses, or frames of reference are just not good enough for accurate prediction and successful manipulation.

There are, today, some useful working hypotheses or ways of looking at human behavior that are sufficiently better than the ordinary layman's viewpoint to warrant serious study by the professional man who finds himself forced to deal with human forces. If he will take the trouble to become familiar with them, he will avoid many false predictions and unpleasant surprises.

Now consider the third characteristic of an engineer, mentioned before. He is master of certain skills and techniques by which the forces and materials of his field may be manipulated to produce desired results. He learns new ones as needed. His techniques are suited to his materials. Now, when his job expands to where people become part of the forces that he handles, what are the new skills and techniques he needs and where does he get them? Some, he has already. Others, he can conceive for himself because they follow logically from the nature of the human materials, and some, he can borrow from those professions that have dealt with human materials all along.

Engineer's Skills

Three of the skills that the engineer will use in manipulating the human parts of his job are: (1) The old familiar skill of observing and analyzing what he is dealing with before he acts upon it. (2) The skill of listening to his people to understand the sentiments that are really important to them so that he can constructively influence their actions. (3) The skill of developing his people by providing learning experiences through which they can grow.

In utilizing these skills, he is operating as a true engineer. He is dealing with his human materials and forces in ways that are in harmony with their nature. By so doing he is able to excercise control and achieve results.

Business Organization

Another thing that often happens to engineers who become supervisors is the recognition that they are working in large organizations with presidents, directors, policies, procedures, regulations, standard practices, and proper channels of communication—all of which often appear to the engineer as a vast conspiracy of frustrations that limit his freedom of action and hinder him in getting his job done. He realizes that he must cope with the demands and relationships required of a member of a larger team. Fortunately, the nature of a business organization is beginning to be understood and described, at least to a useful first approximation, in operational terms that the engineer will be the first to understand. Evidence is accumulating as to how it really works. One of the most useful viewpoints is to look upon the organization as having the characteristics of what physical scientists would call a "closed system," a system in which action applied to any part affects every other part. Many causes are operating at the same time, and many interdependent and reciprocal effects are occurring, just as they are in a complex physical system. Another thing we know is that an organizational system is a place where custom and tradition play a stabilizing part, and where initiative and new ideas often have to wait their turn before they become effective. It is a place where timing often has an important effect on results. So the engineer who does his work in human organization will often have to give consideration to the rate at which organizational changes can be effected and absorbed.

Another thing about an organization is that it is a place where the events and actions that occur are likely to take on meaning to the people in relation to their own purposes and sentiments—meanings that may be quite different from their logical meaning from the standpoint of getting the job done. For instance, when you change a person's work location in the interest of efficiency, he may interpret the change as a threat to his status or advancement and become so upset that whatever efficiency you hope to gain is lost in his performance. The better the engineer knows his people, the better he understands their ways of looking at their situation and the meanings in terms of their own purposes that they attach to everything that happens, the less likely he is to be surprised in this way. The same thing, of course, applies to his contacts upward and outward in the organization, for management people are moved by sentiments and meanings quite as much as anyone else.

So far, we have been looking at the field of action in which an engineer operates when he becomes an administrator and a supervisor of people. Now let's look at the man himself and see if we can sum it all up. What kind of man does it take to succeed in this field and what does he get out of it? What are the requirements, the penalties and the rewards of being a supervisor? Let's take the requirements. They follow from the nature of the materials and forces on which he works and the skills he has to practice to manipulate these forces and get results from them.

Requirements for Success

First of all, he should have the capacity to receive communications. We hear a lot these days about learning to speak well and write well in order to get ahead. These are the capacities of being able to give communications to others. Nobody questions their importance, but the capacity to receive and utilize what other people have to say is often overlooked. A supervisor has to suffer a great many kinds of other people's talk. It comes at him by voice, by ball-point pen, by printed word, and by the mimeograph. If he shuts off the flow he soon finds himself isolated and uninformed in the things he has to know to do his job. Take organizational routines. If he is going to utilize them to facilitate his job and not become enmeshed and blocked by them, he has first of all to become acquainted with them. Communication is a two-way street. In guiding and inspiring his people toward their highest performance, his capacity to listen becomes especially important and sometimes extremely difficult and time-consuming. A supervisor has to be the kind of person who is willing to let other people have ideas and who is able to develop a real interest in hearing about them. This is the way he keeps himself acquainted day by day with forces that he is dealing with so that he can maintain some degree of control over them. The supervisor has to be able to receive communications.

Belief in People

Another quality that helps a supervisor is a broad belief in people. This is a good deal more than a willingness to suffer fools gladly. It is an honest belief that the majority of the people around him really come to the job to work and that one of the main things they want is to see results of their work and know they have accomplished something. Occasionally supervisors let the frustrations and failures of getting things done through people upset them and begin to think that their people don't care very much about getting the job done. This view doesn't fit the facts. To be a supervisor one has to have enough faith in people to remember that the vast majority of them like to work, want to be loyal, and get results just as much as he does.

Supervisors Work Hard

Another requirement of a supervisor is the capacity to work harder, for longer hours, and with a heavier drain of energy than most men are willing to work at any other kind of a job. And that brings us to one of the penalties that the engineer may have to pay when he lets himself be drawn into administrative work. He may or may not be able to maintain his professional competence and keep up to date in the specialized technical field where he began. There is a difference of opinion as to the extent to which it is possible to do both of these things and do them well. Some engineers have attained pre-eminence in their profession while at the same time carrying a heavy administrative load. But without exception these men have been able to do it at the price of extraordinarily hard work.

There is another penalty that the engineer has to pay when his competence pushes him into the supervision of other people. That is the penalty of having to forego the fun of doing things himself. A lot of the things that he enjoyed doing in the laboratory and the shop he now has to tolerate seeing other people do.

What Are the Rewards?

What are the rewards for the engineer who becomes a supervisor? You have your own

opinions about the dollar rewards, so we won't speak of them except to say that where they are larger in supervisory work they are larger for just one reason—that a supervisor contributes more toward getting the total job done than if he were working alone with his own hands, and this points up the real nature of the supervisor's rewards. He is working in a larger field of action. He is manipulating a broader array of forces. He is directing the hands and minds of many men, and the results he can see of his labors are correspondingly greater. That kind of satisfaction is one of his rewards.

There is one more. Have you ever seen a young engineer, the ink still wet on his sheepskin and the moisture just beginning to dry behind his professional ears, floundering hopefully in his first job, pitifully eager to make good, taking assignment after assignment with some failures but more and more successes until one day he blossoms out as a veritable master of his craft? And have you seen the glow of satisfaction in the eyes of the supervisor who bore with him and guided him until this happened? This, I think, is the crowning reward of the engineer who is called to the job of being a supervisor.

ASME Codes and Standards Workshop

F. S. Blackall, jr., Receives Howard Coonley Medal

The Howard Coonley Medal, awarded each year to an executive who has rendered great service in advancing the national economy through voluntary standards, has been awarded this year to Frederick S. Blackall, jr. See the story on the ASA annual meeting on pages 1171–1173.

ABC Unification of Standards

A speech prepared by Frank P. Tisch, Mem. ASME, and one of the signers of the 1948 Declaration of Accord Between Britain, Canada, and the United States, presented "An American Viewpoint" of the ABC unification program at a panel session during the annual meeting of the Standards Engineers Society in Washington, D. C., October 4. Mr. Tisch's talk explained the significance of the unification program to the industrial standards engineer and emphasized that the ABC program was a program of unification of national standards of the three countries, born of the demands of mutual defense.

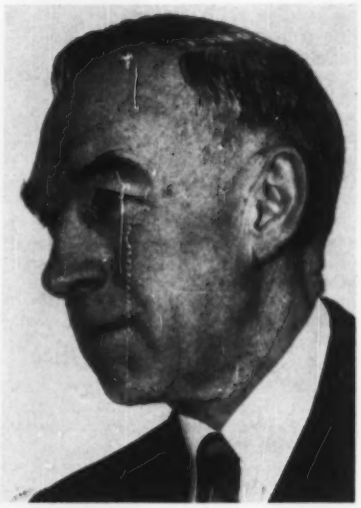
ASA Annual Meeting

For news of the annual meeting of the American Standards Association, see pages 1171–1173.

Aldrich Elected New Chairman of Boiler and Pressure Vessel Committee

Henry E. Aldrich, the new chairman of the ASME Boiler and Pressure Vessel Committee, was graduated from Michigan State University in 1914 with a BS degree and was granted his ME degree in 1923. On graduation he was employed as a draftsman-designer by the Wickes Boiler Company in Saginaw, Mich., and held various positions, including that of general manager, until 1932. In 1933, he became secretary and in 1937 manager of the American Boiler and Affiliated Industries, a trade association in the power-boiler manufacturing field, dealing principally with technical standards.

Mr. Aldrich started working on ASME Code Committee activities in 1917 under Elbert C. Fisher, who was a member of the original over-all Committee appointed by the Council in 1914. Mr. Fisher died in 1925 and in 1927 Mr. Aldrich was appointed in his place on the ASME Boiler and Pressure Vessel Committee. Since that time he has served on various committees, including the Subcommittee on Power Boilers on which he succeeded D. S. Jacobus, Chairman in 1939.



H. E. Aldrich, chairman, ASME Boiler and Pressure Vessel Committee

Since 1944 Mr. Aldrich has been vice-chairman of the Code Committee and chairman of its Executive Committee. He is a Life Member of ASME; a member of the American Welding Society and the American Society for Testing Materials. He is a member of Scabbard & Blade and Tau Beta Pi; a former director of the Air-Pollution Control Association; and a member of the Committee on Engineering of the American Bureau of Shipping.

ASME Council Actions on 1956 National Agenda Reported

How the National Agenda Is Compiled for Regional Administrative Committees and Items Which Are Ultimately Acted on by Regional Delegates Conference

The American Society of Mechanical Engineers has developed a procedure whereby action is taken by all Sections on suggestions made by any Section to improve policies, procedures, and operations of the Society. This procedure starts with the compilation by the National Agenda Committee of preliminary statements of the items suggested. If 25 per cent of the Sections approve any one item, it is included in a National Agenda for discussion at Regional Administrative Committee meetings held in the spring. Further discussion at a national level takes place at the Regional Delegates Conference held during the Semi-Annual Meeting. The results of this Conference are then submitted to the Council.

The principal business of the Regional Delegates Conference held during the Semi-Annual Meeting is to consolidate the actions of the eight RAC meetings on the National Agenda and to report the consolidated view to the Council. Related matters frequently arise on which a consolidated view is developed or on occasion the Council may request the opinion of the RDC on a Society policy or procedure. The Council is usually in session at the same time as the RDC and provision is made for the Delegates to attend the Council Meeting.

A report of the actions of the Conference is made to Council during the Semi-Annual Meeting. The Council after studying the recommendations of the RDC refers to the various administrative agencies of the Society the different items with which those agencies are concerned.

After considering comments received from the administrative agencies, the Council acts on the recommendations of the RDC. These actions were reported to the Delegates and Section Executive Committees on Oct. 22, 1956. Thus the cycle from origination of

items by the Sections to a reporting of actions by Council is completed within one year.

Compilation of the National Agenda

About September 1 of each year the chairman of the Agenda Committee sends forms to the Sections and requests the submission of items by October 31.

Upon receipt of the items, the Agenda Committee reviews them, corresponds with the suggesting Section, and refers the items that can be dealt with promptly, as administrative matters, to the proper administrative agency.

On December 21 a compilation of all items accepted by the Agenda Committee is sent to the Sections for an expression of opinion as to inclusion in the final agenda. By the end of February the Agenda chairman must have all the opinions. Twenty-five per cent of the Sections must approve an item before it can become a part of the National Agenda, which is sent out to all the Sections at least four weeks in advance of the first RAC meeting.

Action in the Sections

The National Agenda requires action in the Section Executive Committee on at least three points:

A In the original suggestion of items. In this process it is desirable to canvass member opinion by some method, by mail, or at a Section meeting.

B The expression of opinion about including an item in the National Agenda.

C A determination of the position the Section is to take on the items in the National Agenda.

It is generally desirable for the Section to select its representatives to the RAC meeting at an early date so that they may be in touch with the entire process of developing the National Agenda.

Copies of this report are available by writing to the Secretary, ASME, 29 West 39th Street, New York 18, N. Y.

A summary of actions by the Council on recommendations of the 1956 Regional Delegates Conference (Cleveland, Ohio) follows.

Final Report on 1956 RDC Recommendations

Agenda Topic No. 2A: Agenda Committee Comment on new RDC Items: New Items introduced at RDC meetings without previously being submitted to the Sections and to RAC conferences shall, after ratification by RDC, be submitted to the Sections. Such Items shall be passed to the Council only if at least half the Sections in each Region vote favorably.

Delegates' Action: APPROVED 12 to 1

Council Action: Does not require Council Action

Agenda Topic No. 13: Limitations on Members of National Nominating Committee: It is proposed that Amend, Sec. 1, Article C7, to read: "The membership of the Society shall elect annually a Regular Nominating Committee, whose duty shall be to select candidates of executive offices to be filled at each annual election. *No member, or alternate, of the Nominating Committee shall be eligible for any executive office of the Society.*"

Delegates' Action: APPROVED 15 to 0

Council Action: This has been taken care of by proposed new Par. 3 of Article B7, which had first reading by the Council June 16, 18, 1956, and which will be adopted by the Council Nov. 24–25, 1956. The new By-Law reads: "No member or alternate of the Regular or a Special Nominating Committee shall be considered for nomination to any elective office of the Society during his membership on a nominating committee."

Agenda Topic No. 14: Comments on Issues Submitted in Membership Ballot: It is proposed that comments by at least two different individuals or organizations, one pro and one con, accompany the ballot for all issues presented to the membership for their vote (*i.e.* excludes elections). The authors of the comments should be selected as someone who is definitely "for" or "against" the issues.

Delegates' Action: APPROVED 9 to 6

Council Action: See following item

Agenda Topic No. 14: Alternate Item: Supplemental Motion Relative to Item No. 14 of the National Agenda—To implement the action recommended in Item No. 14, it is moved that Council be made responsible for the selection of the individuals who will prepare the pro and con statements to accompany ballots.

Delegates' Action: APPROVED 13 to 1

Council Action: The Constitution of the Society requires that any letter-ballot proposing an amendment to the Constitution shall be "accompanied by any comment the Council shall elect to make." Where there is a division in the Council on an amendment to the Constitution or any other issue to be submitted to the members, it is customary for the Council to appoint representatives of the diverse views to meet and agree on the issue to be submitted to the members.

Agenda Topic No. 27: Reduction in Backlog of Unpublished Papers: It is proposed that special study and effort be exerted to find and set into motion ways to reduce and then keep at a minimum the backlog of unpublished technical papers which are to appear in Transactions or MECHANICAL ENGINEERING.

Delegates' Action: APPROVED 8 to 7

Council Action: There is no backlog problem with MECHANICAL ENGINEERING. The backlog referred to occurred in 1954–55 owing to an unexpected reduction in appropriation for printing Transactions. Additional appropriations were made to clean up the backlog of papers, which is now under control.

Agenda Topic No. 40: Original Item: Each Division to Publish Quarterly Newsletter
Alternate Item: Each Division to Publish Report in Special Section of MECHANICAL ENGINEERING

It is proposed that each Professional Division of the Society be required to publish at least every six months a report in a special section of MECHANICAL ENGINEERING set aside each month for Division business activities. This report is to contain:

(*a*) Information about past and future meetings of interest to members of the Division.

(*b*) Information about papers and articles presented, to be presented, and published by members of the Division.

(*c*) Invitations to members to submit papers and suggestions of subjects for papers.

(*d*) Summaries of minutes of Division Committee Meetings.

(*e*) Any news of interest to members of the Division.

Delegates' Action: APPROVED 11 to 4

Council Action: Items (*a*) and (*b*) are already covered in ASME News by means of stories of coming meetings and conferences, advance programs, reports on past meetings, digests of papers presented at meetings and conferences, lists of available papers, and lists of manuscripts sent to the Engineering Societies Library. To separate this material into groups by Divisions would be a duplication of questionable value.

Items (*c*) and (*d*) are the responsibility of the Divisions. Any Division which desires to reach the membership through MECHANICAL ENGINEERING will receive co-operation. The initiative and material must originate in the Divisions.

Item (*e*) is too general and vague to constitute a useful guide to the editorial department.

Agenda Topic No. 43: Formation of New Division: It is proposed that a new Professional Division be formed, namely, "the Maintenance or Plant Engineering Division."

Delegates' Action: APPROVED 15 to 0

Council Action: The machinery has been established within the Society for the formation of new Divisions under Article C10, Article B10, and Article R10 of the Constitution, By-Laws, and Rules. The Professional Divisions Committee will be willing to receive and consider any petition from the sufficiently interested group of members concerning the establishment of such a Division in the field of maintenance or plant engineering.

Agenda Topic No. 48: Expedite Unification of Engineering Profession: It is proposed that ASME exert all possible influence on EJC to expedite the program of unification of the engineering profession.

Delegates' Action: APPROVED 15 to 0

Council Action: The Council (1) endorses the recommendation of the RDC; (2) will request the ASME representatives on EJC to present these views to the EJC Board; and (3) will request the Board on Public Affairs to inaugurate an aggressive program to explain EJC to Section members.

Agenda Topics No. 49 and No. 50: It is proposed that the Society make a strong effort to encourage members to obtain their Professional Engineering license.

Delegates' Action: APPROVED 14 to 1

Council Action: The Council will aid the Sections to carry out their previously assigned responsibility of encouraging members to become licensed engineers, the Engineers Registration Committee and the Vice-Presidents will take immediate steps to develop closer co-operation between the Sections and the Committee and provide them with promotional literature.

Items Rejected

To complete the record, the following Items that appeared on the original Agenda for the Regional Administrative Committee meetings were rejected:

No. 4—10.17; No. 11—10.63.2; No. 40—16.23; and No. 31—13.28.5.

Actions of ASME Executive Committee

At a Meeting at Headquarters, Oct. 15, 1956

A MEETING of the Executive Committee of the Council of The American Society of Mechanical Engineers was held in the rooms of the Society Oct. 15, 1956. There were present: Joseph W. Barker, chairman; F. L. Bradley, and F. W. Miller of the Committee; J. L. Kopf, treasurer and ASME representative on UET; E. J. Kates, assistant treasurer; W. F. Ryan, president-elect; D. W. R. Morgan, past-president; W. H. Byrne, vice-president; R. B. Lea and Joseph Pope, directors; E. G. Bailey, past-president and ASME representative on Task Committee on New Engineering Societies Building; W. F. Thompson and H. E. Martin, ASME representatives on UET; C. E. Davies, Secretary; D. C. A. Bosworth, T. A. Marshall, Jr., and O. B. Schier, 2nd, assistant secretaries; and L. S. Dennegar, public-relations director.

The following actions are of general interest:

ASME Staff. The Committee extended to four members of the staff, one having served 35 years and three 30 years, sincere appreciation of their loyal and faithful service and their valuable contributions to the success of the Society.

Codes and Standards. Upon recommendation of the Board on Codes and Standards approval was voted of the following policy for the translation of ASME Codes and Standards into foreign languages:

1 In principle the ASME should agree to permit translation of our codes and standards into foreign languages.

2 This shall be at no expense to the Society.

3 The Society delegates the responsibility to the national standard body to provide a note (in a prominent place both on the cover and the first page) to the effect that only the original English text is officially recognized and that the translation is made on the responsibility of the national standards body.

4 The Society reserves the right to furnish interpretations should a dispute arise. The complainant is to bear the expense of review by the ASME for each individual case.

5 Each code or standard shall bear the complete designation, including the date, on the cover in both English and the language into which the document is translated. It will also contain a statement under which permission is given for the translation.

Blackall Machine Tool and Gage Award. The Secretary reported receipt of additions to the principal of the Blackall Machine Tool and Gage Award Fund. The President was directed to convey the appreciation of the Society to the Taft-Peirce and the Blackall Foundations.

Fracture of Metals. Upon recommendation of the Research Committee, subject to approval by the Board on Technology and the Organization Committee, it was voted to approve establishment of a Research Committee on Prevention of Fracture in Metals "to study the prevention of fracture in metals from an engineering point of view," with the following personnel: W. F. Brown, Jr., H. D. Emmert, L. R. Jackson, L. F. Kooistra, J. D. Lubahn, M. J. Manjoine, E. R. Parker, George Sachs, and G. M. Sinclair.

Flow of Bulk Materials. Upon recommendation of the Research Committee, subject to approval by the Board on Technology and the Organization Committee, it was voted to approve establishment of a Research Committee on Flow of Bulk Materials "to investigate the various phenomena associated with flow of solid material particles," with the following personnel: R. D. Brandes, A. J. Burke, F. G. Feeley, Jr., J. W. Fogwell, R. M. LaForge, Frederick Marich, J. I. Polaner, J. O. Predale, W. R. Runo, and J. C. Smith.

Boiler Feedwater Studies. Upon recommendation of the Research Executive Committee, subject to the approval of the Board on Technology and the Organization Committee, it was voted to approve the redesignation of the joint Research Committee on Boiler Feedwater Studies as a Research Committee of ASME, with the following personnel: P. B. Place, M. D. Baker, L. Drew Betz, E. A. Pirsh, R. C. Adams, A. A. Berk, R. A. Lorenzini, H. A. Grabowski, E. P. Partridge, and J. F. Wilkes.

Public Relations Committee. The Public Relations Committee was designated a special committee.

ASME Manual on Consulting Practice. On Sept. 7, 1956, Joseph Pope reported that the publication of the ASME Manual on Consulting Practice was being held up in the hope that the EJC Committee on Consulting Practice might come forward with a manual covering all phases of the profession. Since the delay involved would be excessive, Mr. Pope reported that the Professional Practice of Consulting Engineering Committee has issued the ASME Manual on Consulting Practice.

1956 Regional Delegates Conference. Statements and actions on the recommendations of the 1956 Regional Delegates Conference were adopted. (See pp. 1194–1196).

Sections. Establishment of the Western Maryland Group of the Baltimore Section and the Mohawk Valley Subsection of the Syracuse Section was approved.

Social Welfare Law. The Secretary reported that the State of New York has passed a law to curb unscrupulous charitable solicitation which makes it necessary for the Society to be registered as a national body and each of the Sections in New York State to be recorded.

Microcard Foundation. A contract with the Microcard Foundation for the microcarding of the Society's periodicals was approved.

Certificates of Award. Certificates of award were granted to the following retiring chairmen of Sections: John O. Rich, Arizona; Warren M. Rohsenow, Boston; W. J. Verlander, New Orleans; and M. V. Hogan, Utah; and the following secretary and chairmen of Region IV committees: K. R. Daniel, secretary, Region IV; A. S. Morton, chairman, Sections Committee; J. Dillard Jacobs, chairman, Student Branch Committee; J. A. Keene, chairman, Membership Development Committee; and R. M. Donaldson, chairman, Civic Affairs Committee.

New Engineering Societies Center. W. F. Thompson, chairman of the United Engineering Trustees Real Estate Committee, presented a progress report on the New Engineering Societies Center, which included the statement that the firm of Shreve, Lamb, and Harmon Associates has been retained as architects. J. L. Kopf reported that the UET Committee and the AIChE Committee had agreed on a basis for the admission of AIChE to UET membership. The basis of this agreement was approved by the ASME Executive Committee, subject to approval of UET.

Survey of Engineering Profession. The Joint Committee of ECPD and EJC has submitted a proposal for a Survey of the Engineering Profession and recommended that the constituent societies (1) endorse the proposal, (2) endorse the establishment of a joint ECPD-EJC Committee on a Survey of the Engineering Profession, and (3) authorize funds for the initiation of the survey. The proposed committee would (1) outline a form of organization to conduct the survey, (2) appoint a director and a small staff to assist in detailing the program and later administering it under the committee's auspices, and (3) make progress reports to ECPD and EJC. (See pp. 1128–1130.)

The Executive Committee of the ASME Council accepted the report, approved its intent, and appropriated a sum not to exceed $10,000 for initiating the survey "contingent upon similar action by other constituent bodies of EJC and ECPD in accepting their proportionate share of the financial responsibility, and further contingent upon the raising of sufficient total funds to complete the initial project."

Ideal Engineering Registration Law. R. J. Rhinehart, president of NSPE, addressed the presidents of the engineering societies and submitted an Ideal Engineering Registration Law for written comment and open discussion at their Charleston, S. C., meeting, Feb. 14, 1957; EJC, on Sept. 21, 1956, voted:

"1 That the EJC-ECPD Committee on the Practice of Engineering be directed to undertake (*a*) review of the Model Law with

NCSBEE to ascertain what revisions if any might be desirable; (*b*) to develop principles under which existing state registration laws might be modified in the interests of uniformity and the advancement of reciprocity between states; and that these objectives be carried out in the interest of advancing the unity of the profession.

"2 That a representative of this committee be appointed to attend the meeting called to consider the "Ideal Registration Law" scheduled for Feb. 14, 1957, at Charleston, S. C."

The Exective Committee of the ASME Council voted to support the foregoing action of EJC.

Presidential Representative. Appointment of Charles E. Crede as presidential representative at the dedication of a classroom-laboratory building at Northeastern University, Oct. 24, 1956, was voted.

Engineering Societies Personnel Service, Inc. (Agency)

THESE items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members or nonmembers, and is operated on a nonprofit basis.

In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office.

When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

New York
8 West 40th St.

Chicago
84 East Randolph St.

Detroit
100 Farnsworth Ave.

San Francisco
57 Post St.

Men Available[1]

Sales-Engineering Executive, PE, ME, 40; 17 years in design, materials, structures, and tooling contacting airframe, electronic, and aircraft engine manufacturers. Extensive personal contacts in aircraft industry in United States and Canada. Now directing field-engineering force of 70 engineers in technical aspects of nationally known aircraft-fastening device. Strong sales engineering background in light-metals field; magnesium, aluminum, and titanium. ME-346.

Power Engineer, BSME, 32; approximately eight years in steam-power operation. Desires United States. ME-347.

Positions Available

Production-Planning Manager, engineering graduate, college math through Calculus. Minimum of four to six years in production-planning work in an industrial manufacturing company, with a wide number and variety of products. Some preference will be given to experience in job-shop press work. Will report to the chief industrial engineer. To $11,000. Pa. W-4050.

Production-Planning and Control Manager, 34–40, college graduate, engineering and/or business administration preferred, to develop and manage production planning, scheduling, and control for a metal processor-fabricator. Must have production control and/or planning experience at supervisory-managerial level; solid training in and understanding of production-control problems and techniques. Company employs 2000 to 2500 people. $10,000–$12,000. Southeastern New England. W-4092.

Works Engineer, 35–45, mechanical or electrical graduate, ten years' engineering experience in heavy industry, such as steel. Should have broad background and proved record for administrative responsibilities over multiplant operations. Will be responsible for engineering of two plants, one a rolling mill and the other a reduction plant engaged in the manufacture of aluminum. Salary open. South. W-4098.

Teaching Personnel, rank from assistant professor to department chairman, MS required, PhD desirable, to teach machine design, metallurgy, heat power, aeronautical option, nuclear option, or some combination of these fields. Three mechanical engineers and one nuclear engineer required. Rank and salary commensurate with qualifications. Opportunity for year-round teaching on co-op program. Southwest. W-4100.

Senior Engineer, Plant, 30–45, BSME or equivalent, six years' experience, background in heavy machine design, preferably mill equipment, oil-field equipment, mine and smelter equipment, etc. Eighty per cent board work machine design, major layout, project analysis, supervision of work of subordinates, cost analysis on major rolling-mill engineering jobs. Salary open. State of Wash. W-4125.

Senior Machine Designer, six to eight years of machine design, in field of metal-processing machinery. Machine-tool design, packaging, and closure-machine experience considered likely background experience. Will study and evaluate methods of manufacturing heat-transfer surfaces of all types, with a view of actual development of new or improved types of production machines. Ability to think creatively is of utmost importance. $8000–$10,000. Upstate New York. W-4131.

Designers, at least five years' practical experience in basic industries and more particularly in connection with plant layout, equipment installation, and process-machine design. Experience in industrial waste disposal, chemical piping, and foundry operation would be helpful. Must have had technical training and be able to do own preliminary drafting in connection with plant layouts. Salary open. Conn. W-4132.

Assistant Plant Manager, 35–45, mechanical or chemical engineering graduate, at least five years' managerial and supervisory production experience in process manufacturing in drug or allied fields. $12,000–$15,900. N. J. W-4136.

Assistant to Industrial-Relations Attorney, to 30, preferably with undergraduate degree and LLB; should have graduated in at least the top 50 per cent of law class. Must have strong interest and desire for labor law. Will perform a variety of duties related to labor law under supervision. Initial assignments will be in labor-law research and preparation of briefs. Opportunity for advancement. Salary open. Calif. W-4145.

Budget Manager for a manufacturer of precision-metal components; 31–40, BS in business administration, majoring in accounting. Minimum of ten years in industry, five of which should have been in precision-metals manufacturing. Most recent five years should have been in financial control and the last two in a responsible position in budget work. Some experience in a supervisory training program and in manufacturing would be helpful. Will be responsible for installing and operating a Variable Budget Control System. Salary open; fringe benefits. Excellent opportunity to advance into operations management. Mich. W-4148.

Assistant to Senior Development Engineer, heat-transfer equipment, mechanical or chemical graduate preferably with master's degree. Interest and some experience in heat-transfer engineering, to work on projects involving product improvement and new product development in refrigeration, heating, air conditioning and heat exchange. Salary open. Midwest. W-4157.

Development Engineer, BS(ME); 26–35; five to ten years' experience in design and development of pneumatic or hydraulic valves and components in aircraft accessories, to co-ordinate development of mechanical equipment for new commercial aircraft. Company will pay placement fee. $5980–$8060. N. J. W-4165.

Plant Chief Industrial Engineer, IE or ME degree; 30–45, eight to ten years' experience in industrial engineering, preferably in a process industry such as rubber, plastics, paper, floor covering, etc., and a knowledge of time study, rate setting, industrial management, methods improvement, and cost reduction. To $9,000. N. J. W-4171(*a*).

Mechanical Superintendent, at least ten years' field engineering and supervisory experience covering installation of heating, plumbing, power, and process piping, and manufacturing equipment. $7800, minimum. Eastern Conn. W-4174.

Senior Industrial Engineer, 30–40, experience in time study, standards setting, methods, etc., primarily in metals industries, particularly sheet mill-rolling and finishing. To supervise plant projects, such as plant layout, labor usage, engineered standards, time study, etc. Salary open. State of Wash. W-4192.

Manufacturing Manager, 40–45, for company producing mechanical and molded rubber products, chemical-engineering background, to supervise headquarters plant and two branch plants; staff will include plant engineer, industrial engineer, production-control manager in addition to the plant managers. $15,000. New England. W-4198.

Design Engineer for leading manufacturer of core drills and drilling accessories. Will be responsible for the design and development of drilling equipment as well as direction and supervision of necessary drafting personnel. Creative as well as executive ability desirable. Salary open. Pa. W-4199.

Production-Control Specialist, 26–30, preferably a BSA, with a production major, or BS in industrial engineering; desires one year in a management trainee program, followed by a minimum of three years in production-control department of one or two large-sized precision metals manufacturing plants. Some experience in scheduling work. Experience must have been with large job-shop-type of operations. Salary open; company benefits. Mich. W-204D.

Superintendent, mechanical engineer, some supervisory experience and experience in one or more of the following: die and tool design; die and toolmaking; i.e., blanking dies, drawing dies, forming dies, die casting dies; iron foundry; brass foundry; electroplating finishes. Salary open. Mexico. F-4210.

Production Engineering, 30–40, mechanical or metallurgical-engineering training and at least five years' supervisory operating experience in sheet-rolling mill. $9000–$10,000. W. Va. W-4218.

Industrial Engineer, mechanical or industrial engineering degree, to 30, for methods, plant layout, materials handling for fiber-glass molding and assembly operations. Experience in this field desirable. $6000–$6500. Southern N. J. W-4219.

Chief Engineer, graduate mechanical, electrical, or industrial, 35–45, with some experience in management and some background with IBM and Remington machines either in the manufacture, engineering, or use of same. Must have creative ability and be able to supervise group of mechanical and electrical engineers and one chemist. Minimum salary $18,000. Company will pay placement fee. Ill. W-4222C.

[1] All men listed hold some form of ASME membership.

Assistant Professor, preferably industrial-engineering degree, but will consider mechanical, to teach time-motion studies. Should have several years' experience in this field. $5500, for academic year with possibility of additional earnings for teaching extra courses. N. Y. metropolitan area. W-4223.

Superintendent of Maintenance, graduate engineer, or equivalent years of experience, three to five years' experience in responsible supervision and charge of maintenance functions. Will administer installation and repair of equipment, buildings, utilities, etc.; supervise activities of maintenance department, plan order of work and direct plant engineering accordingly; organize a system of preventative maintenance, etc. $7488–$8844. Buffalo, N. Y. area. W-4225.

Chief Development Engineer, 35–45, mechanical or electrical engineering degree or both, with at least five years' electromechanical experience in development engineering, in a supervisory capacity, including responsibility for administering and directing a development-engineering department, product design and redesign, new product development. Long established company in the durable consumer goods field, as well as engineered components and subassemblies made to industrial customers' specifications; i.e., clocks, timing mechanisms, and the like. Salary open. New England. W-4231.

Professor, doctor's degree in industrial or mechanical engineering, 35–45, to expand and teach industrial engineering courses. Broad experience in industrial engineering highly desirable. Should be interested in academic work with a strong desire to teach. Salary open. N. Y. metropolitan area. W-4232.

Design and Construction Engineer, at least five years' experience in pre-stressed concrete construction. $7000–$9000. Upstate N. Y. W-4234.

Administrative Secretary for national engineering society. Must have ability in management, public relations, publication production, advertising, publicity programming, membership activities and budgets. Salary open. Midwest. W-4236.

Engineers. (*a*) Engineering specialists, four; one in each of the following categories: (1) fluid mechanics; (2) controls; (3) stress and vibration; (4) combustion. $9600–$14,400. (*b*) Development engineers with at least three years' experience in the development of high-speed turbines and pumps or automatic engines. Will be used on development of the following aircraft equipment: (1) high speed gas turbine drives for auxiliary power on military aircraft and missiles; (2) air-turbine motor drives for aircraft nuclear propulsion engines; (3) turborocket pumps. $7200–$9600. Ohio. W-4240.

Plant Manager, to take charge of 600-man shop manufacturing industrial type pumps, motors, valves. Will be responsible for manufacturing, production, control, maintenance, purchasing, etc. Salary open. Mich. W-4243.

Machinery Designer, graduate mechanical engineer, three to five years' experience; industrial experience in design of heavy machinery, preferably in the power-machinery field. $6000–$9000 and up; company pays placement fees and relocation expenses. Conn. W-4247.

Engineers. (*a*) Mechanical or aeronautical engineer, at least BS in mechanics or aeronautics, preferably with three to five years' experience, specialist in fluid flow, aerodynamics and fluid machinery. Duties will be fan, compressor, and turbine design. (*b*) Machinery designers, BS or higher in mechanical engineering with five to ten years' experience in machine design. Should have knowledge of electromechanical control systems. Initial work will be in design of controllable pitch propellers, actuators, and controls. Later assignments will include other types of automatic machinery. (*c*) Marine or mechanical engineers, BS or higher in mechanics or marine engineering; can be recent graduates. Interest or specialty in thermodynamics and power engineering. Must have facility in mathematical analysis of power plant design problems. $6000–$9000; company pays placement fees and relocation expenses. Conn. W-4248.

Executive Vice-President for a trade association, college training or equivalent such as provided by graduation from West Point, Annapolis, or other accredited service academies; mature enough to have sound judgment. Will be responsible for the full-time administration and leadership of the affairs of the association, including employment and direction of staff, publications, library, membership files, and data, preparation for meetings, agenda, minutes and records, etc. Previous successful experience in association management is desirable, in lieu thereof, a record showing successful group management. Salary open; advise as to salary requirements. Midwest. W-4250.

Process Manufacturing Engineer or Production Engineer, to set up straight assembly line for company manufacturing small electrical equipment. Must know tooling, control, etc. Will eventually head up department. To $10,000 Newark, N. J., area. W-4253.

Project Engineers, mechanical or electrical graduates, from two to five years' experience, preferably in project or product design of electromechanical equipment. Company manufactures industrial fans, blowers, etc. To $7500. Northern N. J. W-4254.

Candidates for Membership and Transfer in ASME

THE application of each of the candidates listed below is to be voted on after Dec. 24, 1956, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

New Applications and ●Transfers

Alabama

NUNNELLEY, BENNY, Arab
SELLERS, JEFF C., JR., Chickasaw

California

● BALENT, RALPH, Tarzana
● BECK, EARL J., JR., Oxnard
BLAKE, RUSSELL, La Crescenta
BROUGHER, JACK L., Gardena
● DONEY, SIDNEY S., JR., Norwalk
● HEFFRON, PAUL, Hollywood
HOLCOMB, LOWELL A., Pomona
HORST, KENNETH M., San Jose
KAPLAN, ABNER, Los Angeles
MORRISSEY, GEORGE F., JR., Fremont
OLSON, JOHN H., San Francisco
OTTINGER, C. WAYNE, Lancaster
● SCHANZ, JOSEPH L., Campbell
● SELENE, LLOYD J., Mountain View
UNION, DONALD C., Emeryville

Colorado

ARNBERG, BENJAMIN T., Boulder
SPRINGER, FRANCIS, Boulder
WRIGHT, WILBUR M., Boulder

Connecticut

● BERNAT, RICHARD R., Hartford
● BERNSTEIN, RALPH H., New Haven
ROSS, STEWART H., Hartford
SPECHT, RALPH B., Greenwich

Delaware

LEWIS, THOMAS G., JR., Wilmington

District of Columbia

COHEN, MORITZ A., Washington

Florida

BARTLETT, ULYSSES K., Panama City
BIEGLER, WARREN H., Panama City
MCGAW, JACK C., Panama City

Idaho

● WATANABE, HOWARD T., Idaho Falls

Illinois

BOOTH, LEONARD J., WINNETKA
● BRENNAN, MARTIN J., Homewood
● CAMBEL, ALI B., Evanston
CHIARULLI, PETER, Chicago
GAUDETTE, PAUL R., Chicago
● HOUSIAUX, JOHN E., Decatur
● MANKUS, ROMAN T., Wilmette
NELSON, CLIFFORD H., Chicago
ORTJEN, DONALD V., Chicago
VANDER MOLEN, JACK J., Chicago
● WENZEL, HANS H., Chicago

Indiana

BURGE, JOSEPH, Indianapolis
DELLEUR, JACQUES W., Lafayette
SCHEINEMAN, FRED W., Whiting
● SCHROLUCKE, VIRGIL H., Richmond
STEPHANOFF, LOUIS J., Indianapolis

● Transfer to Member or Affiliate.

Iowa

WASSON, VAN R., Davenport

Kansas

DRAKE, MARVIN E., Kansas City

Louisiana

HOLT, W. T., Baton Rouge
LEBLANC, GERALD A., Baton Rouge
LEONARD, LEON C., New Orleans
● MULLER, RICHARD F., JR., New Orleans
THOMPSON, CHESTER W., Baton Rouge

Maryland

● CLARK, JAMES A., College Park
● KOROBKIN, IRVING, Silver Spring
MENTLIK, EDWARD N., Baltimore
SMITH, RICHARD G., Baltimore

Massachusetts

HALLINAN, MARK, Lynn
● PRICE, M. LAWRENCE, Worcester
REISSNER, ERIC, Weston
RUSSELL, DANIEL, Boston
SPITZ, S. LEONARD, Hyde Park
STILES, WILLIAM S., Salem
TANG, ARTHUR V. C., South Boston
WALKER, DONALD R., Lawrence
WING, PAUL, JR., Hingham
ZIMMERMANN, ROBERT E., Cohasset

Michigan

BROOKS, AARON D., Midland
HEIDEL, CHARLES M., Detroit
MALOHN, DONALD A., Garden City
● MERRELL, RICHARD L., Royal Oak
PURDY, DAVID C., Ann Arbor
WILSON, FRANK W., Plymouth

Minnesota

CONKEY, DAVID R., Minneapolis
MARKEY, STANLEY E., Minneapolis
RANG, EDWARD R., Minneapolis

Missouri

● NADLER, GERALD, St. Louis
SIMPSON, DAMON G., Kansas City

Nebraska

STOCKHOLM, DONALD D., Lincoln

New Jersey

BURG, HAROLD, East Paterson
HART, A. BEATRICE, Somerville
KIDDOO, DONALD B., Union
ROBINSON, WILLIAM D., Paterson
STETT, JOSEPH D., Highland Park
TURRO, EDWARD R., Montclair
YOUNG, WILLIAM, Bound Brook

New Mexico

KIDD, RICHARD, JR., Albuquerque

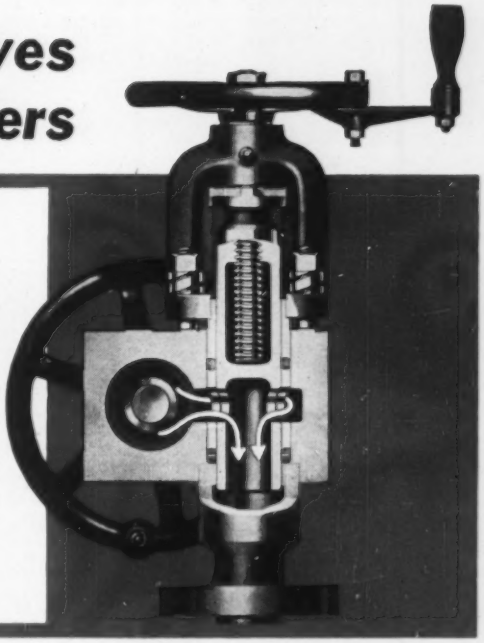
New York

AMOROSO, JOHN D., Lockport
BERTZ, LESLIE E., Utica
● BRESLAUER, DAVID M., White Plains
CARHART, DONALD R., Poughkeepsie
CASESSA, ANTHONY F., Brooklyn
CASTLE, WILLIAM R., Liverpool
COBB, BERNARD W., Troy
COYNE, THOMAS D., East Williston
FIEDLER, LIONEL M., Wantagh
KNOP, PETER, New York
LETICH, MATHEW J., New York
LEUENBERGER, HANS, Niagara Falls

(ASME News continued on page 1200)

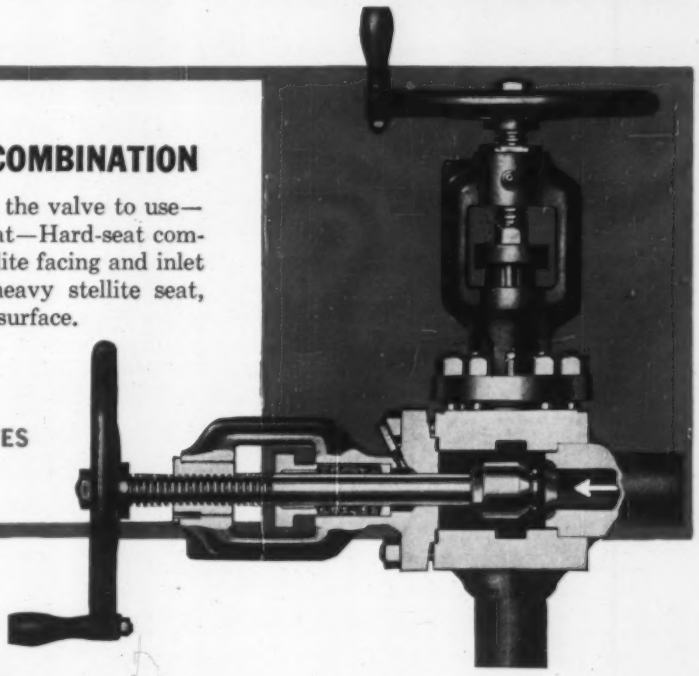
UNIT TANDEM

rugged blow-off valves for high pressure boilers



HARD-SEAT—SEATLESS COMBINATION

■ For boilers up to 1500 psi, this Yarway Unit Tandem Blow-Off Valve offers the maximum in dependable service. A one-piece forged steel block serves as the common body for the Yarway Stellite Hard-seat blowing valve and the Yarway Seatless sealing valve. All interconnecting flanges, bolts and gaskets are eliminated. The Unit Tandem at right is sectioned through Seatless Valve to show balanced sliding plunger in open position and free flow.



HARD-SEAT—HARD-SEAT COMBINATION

■ For boilers to 2500 psi, this is the valve to use—Yarway's Unit Tandem Hard-seat—Hard-seat combination. Disc has welded-in stellite facing and inlet nozzle has integral welded-in heavy stellite seat, providing smooth, hard-wearing surface.

OVER 4 OUT OF 5
HIGH PRESSURE PLANTS
USE YARWAY BLOW-OFF VALVES

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Quance, Ralph M., Rome
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Shafran, Arthur, New York
● Silfin, Howard, Bethpage
Slot, Thomas, Schenectady
Vigdor, Arthur, New York
Wallis, Robert J., East Syracuse
Walsh, Francis W., Endicott
Zwicky, Everett E., Jr., Schenectady

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Kalwaitis, George V., Charlotte
● Ketner, Donald M., Kinston

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Cardenas, Armando, Akron
● Carroll, James A., Cincinnati
● Davey, Paul H., Jr., Kent
Hauf, Josef, Massillon
Lamb, Harold P., Akron
Litzler, Thomas C., Cleveland
Lucy, Jesse J., Hamilton
Marsh, David C., Maple Heights
Moritz, Donald B., Jr., Cleveland
Petersen, Myron L., Cincinnati
● Scanlan, Thomas R., North Canton
● Schweiger, Frank A., Cincinnati
● Tillwick, Frederick H., Cuyahoga Falls
● Tyner, Robert E., Toledo
Winnail, Paul F., Canfield
Wyss, Frederic D., Cleveland Heights

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Farrell, Ray E., Tulsa
●Janco, Albert N., Oklahoma City

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Crawford, James D., Pittsburgh
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Griffith, Harry W., Ambridge
Hennessy, John J., Erie
Keady, Richard J., Monroeville
Kennedy, George R., Berwick
Krash, Mark F., Philadelphia
Kudlick, Michael, Pittsburgh
Kuzma, Gregory, Philadelphia
Merritt, James S., Jr., Philadelphia
Openchowski, Andrew K., Broomall
Schultz, John M., York
● Showers, Richard F., Allentown
Weglarz, Walter P., Philadelphia

South Carolina

Bennett, Earl R., Camden
Johnson, Kenneth C., Seneca
Stabovitz, Peter C., Ehrhardt

Tennessee

Muller, George L., Oak Ridge
● Nichols, William E., Knoxville

Texas

● Buttrill, Sidney E., Houston
Felps, Newton O., Baytown
Filban, Thomas J., Jr., Houston
● Hansen, Edward P., Houston
Hollingsworth, Cecil E., Houston
Housworth, Gordon C., Houston
Mahoney, Daniel R. H., Houston
Marks, William M., Beaumont
Moore, Richard A., Lake Jackson
● Pierson, Thomas H., Channelview
● Senturia, Harvey, Lake Jackson
Shelton, J. Maxel, Pampa
Valliant, Charles B., Dallas

Virginia

Blow, Edward B., Norfolk

Washington

Bolender, David F., Richland
Heffner, John M., Richland
Waibler, Paul J., Seattle

West Virginia

Jensen, Richard D., Charleston

Wisconsin

● Grogan, Paul J., Madison
Hutchens, Morris L., Milwaukee
Philippi, John, Madison
Plummer, F. Timothy, La Crosse
Speisman, Camille, Milwaukee
Swainson, Gustav F., Jr., Sturgeon Bay

Foreign

Abubaker, S. M., Lahore, W. Pakiston
Alvarez, Manuel C., Oriente, Cuba
● Amin, Nanubhai B., Baroda, India
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Boyd, Alexander, Toronto, Ont., Canada
Chamberlain, Joseph, Derby, England
Clark, Alex H., Hamilton, Ont., Canada
Diehl, Emile J., Delft, Holland
Duncan, Richard A., Honolulu, T. H.
Haneef, Mohammad, Goteborg, Sweden
LeSeeleur, Louis A., Montreal, P. Q., Canada
Montalvo-Rivera, Tomas, San Juan, Puerto Rico
Pfefferkorn, Gerhard A., Scarborough, Ont., Canada
Sanchez, Juan M., San Luis Potosi, Mexico
Thomann, Robert, Winterthur, Switzerland

Transfers from Student Member to Associate Member 111

Obituaries

Oscar Henry Dorer (1888–1956), consulting engineer, Harrison (N. J.) Division Pump Engineering Section, Worthington Corp., died Aug. 15, 1956. Born, Irvington, N. J., Jan. 5, 1888. Parents, Michael and Rose C. (Etling) Dorer. Education, ME, Stevens Institute, 1910. Married Minna Kniep, 1916. Jun. ASME, 1912; Assoc-Mem. ASME, 1921; Mem. ASME, 1935. Held several patents pertaining to pumps and was author of technical papers covering centrifugal pumps, water works, and flood-control pumping projects. Notable of the irrigation projects on which he worked was the Central Valley Project, Tracy, Calif. The pumping station at Tracy was designed to take water from the Sacramento River at a rate of 2 million gal per minute and pump it 200 ft uphill into the Delta Mendota Canal from which it flows in a southerly direction providing irrigation to many miles of farm land in the San Joaquin Valley, before emptying into the San Joaquin River. With Elton Towle, New York, N. Y., he designed the float-control device for pumping stations, the first of which was used in the Nut Island Sewage Plant of the Metropolitan Commission of Massachusetts, one of the largest and most outstanding sewage plants in the world at the time.

Herman Richard Freund (1886–1956), works manager, chief engineer, Intertype Corporation, Brooklyn, N. Y., died Aug. 18, 1956. Born, Suhl, Germany, May 8, 1886. Parents, Mr. and Mrs. August Freund. Education, ME, Polytechnic Institute of Brooklyn, 1927. Married Eunice Wilshear; one son, Robert. Naturalized, Brooklyn, N. Y., 1926. Mem. ASME, 1928. Held several patents on typesetting machines.

Walter M. Keenan (1888–1956), consulting engineer, New York, N. Y., died Aug. 26, 1956. Born, Brooklyn, N. Y., July 14, 1888. Parents, James and Ellen (Milburn) Keenan. Education, ME, Cornell University, 1911. Married Edith Cavanagh, 1924; sons, Walter M., Jr., and John C. Assoc-Mem. ASME, 1917; Mem. ASME, 1928. Served on several ASME committees; Executive Committee, Metropolitan Section, 1924–1928, chairman, 1929; Library Committee, 1923–1934, chairman, 1934. Held patents on water cooling boiler furnaces and automobile-storage elevators. Author of technical paper "Heat Balance of Power Plants." Served for several years on the Bulk-Milk Dispensing Devices Committee of the Department of Health, New York, N. Y. Survived by wife, Mrs. Edith Cavanagh Keenan; two sons, John C. and Walter M. Keenan, Jr.; and a sister and a brother.

Kenneth Campbell Kern (1900–1956), production engineer, Western Precipitation Corporation, Los Angeles, Calif., died July 3, 1956. Born, Washtenaw County, Mich., Jan. 25, 1900. Education, attended Cleary College, Ypsilanti, Mich., 1917; ICS. Mem. ASME, 1955.

Kennety F. LaMothe (1906–1956), chief estimator, Oil Division, Arthur G. McKee Company, Cleveland, Ohio, died March 31, 1956. Born, Brooklyn, N. Y., March 5, 1906. Education attended Polytechnic Institute of Brooklyn, Mem. ASME, 1937.

Carl Brynolf Lundstrom (1899–1956), founder and president, Lundstrom Laboratories, Inc., Herkimer, N. Y., died May 30, 1956, at Cooperstown, N. Y. Born, Little Falls, N. Y., July 21, 1899. Parents, Carl John and Gertrude (Oppel) Lundstrom. Education, ME, Rensselaer Polytechnic Institute, 1923. Married Helen B. Whitehead, 1924; sons, Carl William and David Brynolf. Jun. Mem. ASME, 1925; Assoc-Mem. ASME, 1934; Mem. ASME, 1935. Chairman, Wood Industries Division, ASME, 1942–1947. Held about ten patents on the densification of wood for commercial and institutional furniture and for the wooden components used in the textile industry.

Ralph Walton Macklin (1872–1956), master mechanic and plant engineer, Wickwire Spencer Steel Co., Worcester, Mass., died June 24, 1956. Born, Alexander, Maine, Feb. 10, 1872. Parents, John L. and Maria R. Macklin. Education, ICS. Married Margaret May Chandler, 1902; children, Paul C., Earl L., Ralph W., Jr., and Eva (Macklin) Henle. Mem. ASME, 1938.

Anthony Clement Melanson (1893–1955), chief of motive power and car equipment, Canadian National Railways, Montreal, Que., Canada; died Oct. 14, 1955. Born, Scoudouc, N.B., Canada. Education, attended Toronto Tehnical School; McGill University; ICS. His railroad career began with Intercolonial Railway, 1911–1919; joining the Canadian National Railways the latter year, and becoming material inspector, 1922; superintendent of shops, 1924; and superintendent of motive power and car equipment in 1937. Mem. ASME, 1952.

Frederick Clouston Moore (1870–1956), retired, formerly vice-president, Canton Forge and Axle Co., Canton, Ohio, and of the Vermilion Malleable Iron Co., Hoopeston, Ill., died May 9, 1956, Detroit, Mich. Born, Brookline, Mass., Feb. 5, 1870. Education, SB, Massachusetts Institute of Technology, 1891. Married Ellen M. Palmer, 1903; sons, David P. and Philip E. Mem. ASME, 1905. Survived by his sons.

Howard Louis Pope (1897–1955), district manager, Machine Tools Division, Cincinnati (Ohio) Milling Machine Co.; died Sept. 4, 1955. Born, Cincinnati, Ohio, Nov. 12, 1897. Education, BME, University of Cincinnati, 1922. Mem. ASME, 1945.

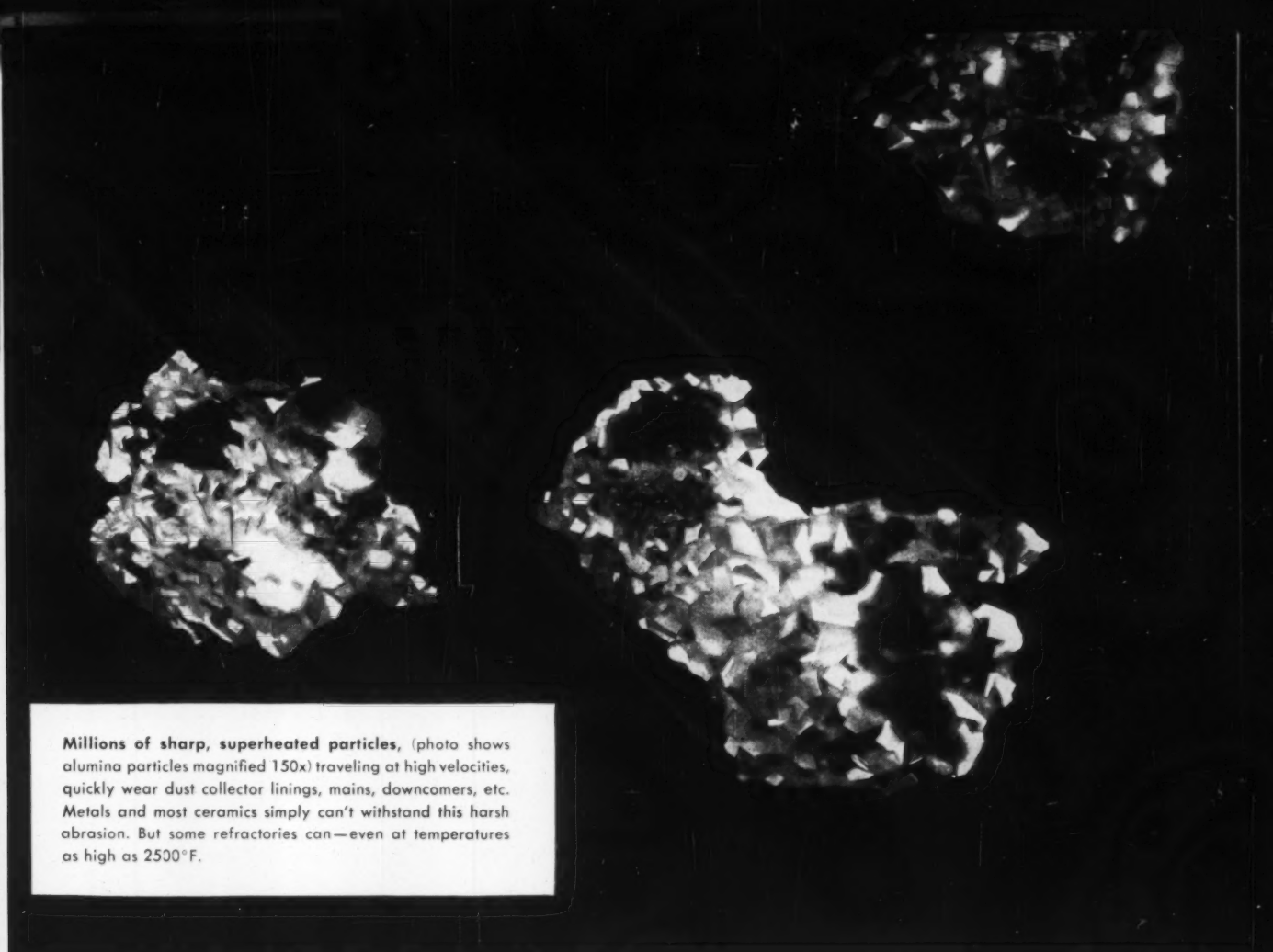
Orville R. Pratt (1904–1956), design engineer, U. S. Supply Co., Omaha, Neb., died May 7, 1956. Born, Lamoille, Iowa, Aug. 29, 1904. Parents, Oscar and Minnie Pratt. Education, attended University of Omaha; ICS courses. Married Dorothy A. Kibbie, 1926. Mem. ASME, 1942. Survived by wife; two children, Jayne A. Mitchell, Council Bluffs, Iowa, and Nancy.

Edward Ambrose Russell (1887–1956), vice-president in charge of engineering, Vapor Heating Corp., Chicago, Ill.; died July 20, 1956. Born, Renovo, Pa., July 11, 1887. Education, attended Armour Institute. Mem. ASME, 1946. Author of a technical paper on railroad-car heating. He held a total of 88 U. S. and Canadian patents, 37 of them individually and 51 jointly with another person, as well as patents in Australia, Belgium, England, France, Germany, and Sweden.

Gordon William Simonds (1930–1956), treasurer, Simonds Tool Corp., Syracuse, N. Y., and lieutenant, Air National Guard serving with the 138th Fighter Interceptor Squadron, Hancock Field, was killed April 28, 1956, when his jet plane crashed in Skaneateles Lake. Born, Syracuse, N. Y., Dec. 9, 1930. Parents, Edson C. and Doris (Wheaton) Simonds. Education, BME, Rensselaer Polytechnic Institute, 1953. Jun. ASME, 1953. Survived by his parents; a brother, Donald W., Red Bank, N. J.; and his maternal grandmother, Mrs. Mary D. Wheaton.

Haakon Styri (1886–1955), director of research, SKF Industries, Inc., Philadelphia, Pa.; died Sept. 13, 1955. Born, Kristiania (Oslo), Norway, March 17, 1886. Parents, Nicolai Bernhard Hansen and Anna (Haug) Styri. Education, ME and ChE, Kristiania Technical School, Oslo, 1907 and 1909, respectively; postgraduate study, Carnegie Institute of Technology and The Sorbonne; Dr. Ing., Koenigliche Technische Hochschule, Aix-la-Chapelle. Naturalized U. S. citizen, Philadelphia, Pa., 1935. Author of numerous technical papers; he was an American-Scandinavian Foundation Scholar, 1909–1910. He began his career as a docent on the metallurgy of iron at Trondheim, Norway, 1912–1917; followed by an assistant professorship in metallurgy, Carnegie Institute of Technology, 1917–1919. In 1920 he joined SKF as chief of the research labo-

(*ASME News continued on page 1202*)



Millions of sharp, superheated particles, (photo shows alumina particles magnified 150x) traveling at high velocities, quickly wear dust collector linings, mains, downcomers, etc. Metals and most ceramics simply can't withstand this harsh abrasion. But some refractories can—even at temperatures as high as 2500°F.

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From the master file are made the lists of members registered in the Professional Divisions. Many Divisions issue newsletters, notices of meetings, and other materials of specific interest to persons registered in these Divisions. If you wish to receive such information, you should be registered in the Division (no more than three) in which you are interested. Your membership card bears key letters, below the designation of your grade of membership and year of election, which indicate the Divisions in which you are registered.

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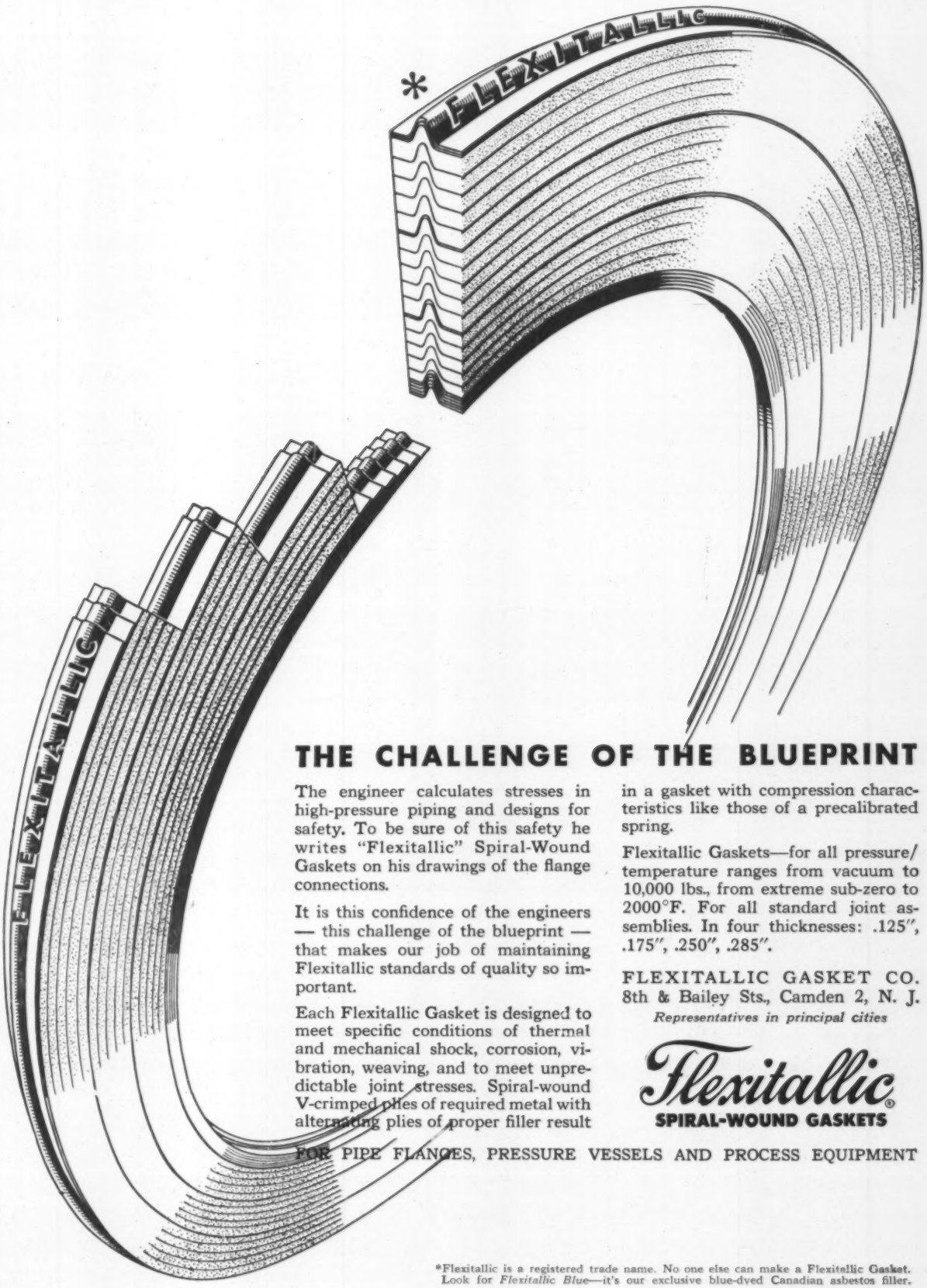
ratory and became director of research for SKF Industries in 1926. Mem. ASME, 1925.

Walter Jacob Wohlenberg (1888–1956), retired dean of Yale University School of Engineering, died Aug. 8, 1956, at New Haven, Conn. Born, Lincoln, Neb., Feb. 17, 1888. Parents, Peter Jacob and Gretchen (Tyschen) Wohlenberg. Education BS(ME), University of Nebraska, 1910; MS(ME), University of Illinois, 1916; hon, DE, University of Nebraska, 1937; MS, University of Illinois, 1914; hon. MA, Yale University, 1928. Married Charlotte A. Spangler, 1918, died 1949; daughter, Barbara (deceased). Married 2nd, Eleanor Bradley Hutchins, 1950. A pioneer investigator and world authority on heat transfer by radiation, he received the Sigma Tau merit award in 1955; the Yale Engineering Association's award for meritorious service to Yale University, 1928. He entered the U. S. Army in 1918 as a private and was assigned to Yale in the Signal Corps to organize and teach a course for officers. Later that year he joined the Yale faculty as an assistant professor and was promoted to associate professor in 1925. He became a full professor of mechanical engineering in 1930 and the same year was named to the Sterling Professorship in the Department. Also he served as dean of the Engineering School from 1948 until his retirement in June, 1955. At the time of his death he was chairman of the Yale committee in charge of an international symposium for engineers, scheduled to be held August, 1956, under the auspices of the Combustion Institute. He was also a consultant to the Wright Aeronautical Division, Curtiss-Wright Corp., Woodbridge, N. J., and The Babcock and Wilcox Co., New York, N. Y. The author of numerous technical papers and a member of the Division of Engineering and Industrial Research of the National Research Council, he was elected Fellow ASME, 1942. Mem. ASME, 1925; Assoc-Mem., ASME, 1917. He served the Society as chairman, Fuel Test Code Committee, 1930–1945; special research committee on radiation in boiler furnaces, 1934–1941; main committee, Power Test Codes; member Committee on Meetings and Programs, 1936–1941; chairman, 1941; he was Vice-President, ASME, 1943–45; member, main committee on Furnace Performance Factors; subcommittee on Heaters in Furnaces. Survived by wife; a brother, Ernest T. F. Wohlenberg, professor of industrial forestry at Yale; and a stepson, Lieut. S. William Hutchins, U.S.A.

Baldwin Munger Woods (1887–1956), retired vice-president of the University of California, died Sept. 7, 1956. Born, Lampasas, Texas, Sept. 22, 1887. Parents, Michael Leonard and Eloise (Munger) Woods. Education, EE, University of Texas, 1908; MS, University of California, 1909; PhD, 1912; hon. DE, South Dakota School of Mines, 1941; DS, College of Osteopathic Physicians and Surgeons, Los Angeles, Calif., 1942; also studied at the Universities of Paris and Munich. Married Bessie Harshman, 1918; sons, Baldwin Charles, Robert Harshman, Ronald Munger. Chosen by a national poll of 2500 engineering graduates selected from the membership of the leading American professional engineering societies as one of the most effective teachers of engineering in the country, he was also one of the most versatile. Whenever a professor was unable to meet one of his classes, it was Dr. Woods who always came to the rescue, and at one time or another he taught more than 25 courses, practically all of the subjects in the mechanical-engineering curriculum. He also introduced the study of aerodynamics at the University of California. A faculty member for 47 years, he served at various times as university examiner, chairman of the department of mechanical engineering, associate dean, and director of University Extension, prior to his appointment as vice-president. The state wide activities in the field of adult education more than tripled under his leadership. From 1942 to 1944 he was vice-chairman, University War Council. Author of numerous technical papers he had written extensively on aerodynamics engineering economy, and adult education. Mem. ASME, 1927; Fellow ASME, 1948. Among the many professional and educational honors held by Dr. Woods were: past-president of the American Society of Heating and Ventilating Engineers; former member of the California State Planning Board; Former member of the California State Defense Council; former chairman of the Water Resources Committee of the National Resources Planning Board; and engineering and educational consultant for many private, state, and national organizations. He was extremely active in the affairs of the ASME Aeronautics Division; Applied Mechanics Division; and worked with the Committee on Nuclear Engineering Applications on the ASME proposal for co-operation with the U. S. Atomic Energy Commission on educational programs to promote increased industry activity in atomic work. He was a Founder member of the IAS and in 1940 he was chairman of ECPD Region VII.



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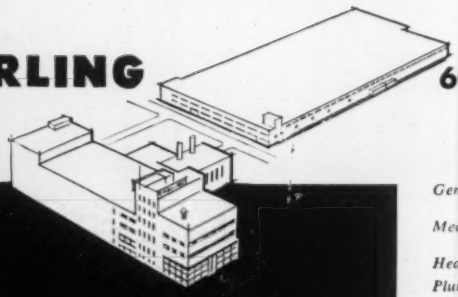

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JENKINS VALVES

control piping planned for new standards of brewing efficiency

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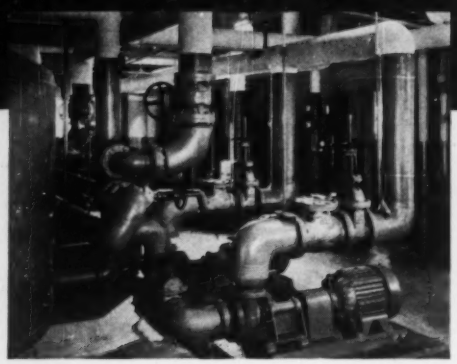
In layout for operating efficiency, as well as appearance, the Carling plant sets new standards. All equipment was selected to meet the critical requirements of this advanced design. Over 2000 Jenkins Valves were installed on the basis of proved dependability, safety, and long-range maintenance economy.

This *extra value* built into Jenkins Valves is recognized by plant operating managements in every type of industry. Let the Jenkins Diamond be your guide to lasting valve economy. Jenkins Bros., 100 Park Ave., New York 17.



JENKINS VALVES selected to control steam, water, waste, and processing pipelines include many sizes and patterns of bronze, iron, cast steel, and stainless steel valves. Illustration shows large iron gate and check valves in the filtered water pump system.

JENKINS
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VALVES
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Available literature or information may be secured by writing direct to the manufacturer. Please mention MECHANICAL ENGINEERING.

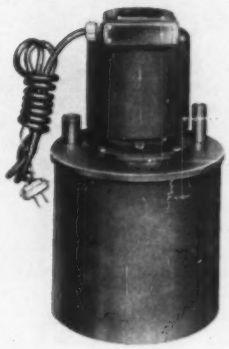
NEW EQUIPMENT

Masonry Liquid Coating

Surfa-Sele masonry coating, a pigmented protective sealer that can be applied over damp masonry surfaces for the prevention of moisture seepage and dampness damage, is available from Rust-Oleum Corp., 2799 Oakton St., Evanston, Ill.

The coating is supplied in liquid form and formulated with a specially-processed fish oil vehicle. This vehicle has the property of unusually low surface tension, the firm says, which results in unique penetrating and wetting ability. When the product is applied over a damp masonry surface from which excess surface moisture has been removed, the vehicle penetrates deep down into the pores of the surface. Because it has more wetting power than water itself, it actually displaces trapped moisture and surface water and adheres tightly to the surface. It dries to a tight, tough, semi-gloss white finish that resists dampness. Finish coats for indoor use can be tinted with colors-in-oil.

According to the company, the coating contains no lead or other harmful elements, and can be used in canneries, dairies, and other food processing plants where moisture and steam present a maintenance problem. It is recommended for all kinds of masonry surfaces, including brick, concrete, stucco, asbestos siding, concrete block. Its unusual sealing properties are also useful where wood, wallboard, plaster, etc. are subjected to moisture and dampness.



Pump Unit

Ruthman Machinery Co., Cincinnati 2, Ohio, announces a newly developed pump and tank unit, No. 4072-T, for handling abrasive materials such as silicon carbide solutions on honing, lapping and ultrasonic machines.

The reason this unit is capable of handling abrasives is because there are no bearings, seals, packings or dependent close tolerances in contact with the material being pumped, the firm states.

The assemby consists of a $^1/_{10}$ hp model 1 P3 long gusher centrifugal pump and a steel tank complete with inlet and discharge pipe connections and also electric cord and plug. The pump is equipped with a motor having a heavy suspended shaft which rotates on two generous size precision ball bearings, within the motor mounted above the tank lid.

An even mixture of the liquid is maintained automatically at the internal hemispherical shaped tank bottom. The tank is available in all stainless steel or standard carbon steel as specified.

Galvanometers

Three new instruments with extended frequency and sensitivity ranges have been added to the 7-340 series of high-performance galvanometers by Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.

According to the company, these galvanometers provide higher frequency response without sacrifice of sensitivity. For the same frequency range, compared to previous galvanometers, sensitivity is quadrupled, thus opening a completely new field of low output strain-gage applications. In general, the higher performance in the new galvanometers has been accomplished by further miniaturization of microscopic moving parts, made possible by new materials and production techniques, the firm states.

Two of the three new types, 7-347 and 7-348, are designed to match the commonly-used strain-gage-bridge resistances of 120 ohms. The third type, 7-341 matches resistance bridges of 350 ohms. All models in the 7-340 group are interchangeable with any of the company's 7-300 series galvanometers.

Edge Guidance System

Intercontinental Dynamics Corp., 170 Coolidge Ave., Englewood, N. J., has announced the Linar Edgetrol photoelectronic edge guidance system, designed as an answer to runout of continuously processed material in elimination of edge waste.

The unit is completely self-contained and fully automatic. Seven versatile sensing heads provide a variety of models. Since edge detection is by photoelectric means, no force or pressure is applied to the material under control.

Used for accurate printing, coating, tubing and rerolling, slitting and punching, tentering, intersheeting and manifolding, this new system controls edge registration and web position of all opaque materials, porous materials such as lace, gauze, screening, netting and nonwoven fabrics, single thickness films such as polyethylene, vinyl and cellophane and laminates, the company reports.

Capable of maintaining control accuracies with $^1/_{32}$ in. at any speed, the systems are available in three integrated forms for use with present web control equipment as well as in new applications where edge control has previously been impossible.

Standardaire Blower unloads 20 tons of flour in 50 minutes

In the next 50 minutes, this one operator will have unloaded twenty tons of flour from this huge International Milling Company trailer directly into a baker's storage bins.

The problem of rapidly unloading flour in such quantity, with no leakage, clogging or contamination, was solved by a *Standardaire* blower . . . the only blower found capable of meeting all the specific requirements involved.

This blower (shown in the front of the van) occupies a floor space of only 26″ x 21¾″. When driven by a 20 hp motor it provides an air flow sufficient to move flour as far as 125 feet in any direction . . . including straight up.

Today, due to its proved satisfactory performance, International Milling Company, Minneapolis, one of the largest millers of bakery flour in America, has equipped its entire fleet of bulk flour trucks with *Standardaire* blowers.

A *Standardaire* blower will deliver more air, with less power consumption, than any other unit of equal size or weight. Find out about its many advantages. Write for bulletin B-154 today.

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KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

Maintenance Coating

Metal & Thermit Corp., Dept. 1400, Rahway, N. J., has introduced a new vinyl maintenance coating, Ucilon Coating 1400, to provide the corrosion resistance of previous vinyl-based coatings and eliminating strong odors and the need for meticulous surface preparation.

The firm says the coating can be used for walls, floors, ceilings and the exteriors of equipment to resist corrosive fumes in chemical processing plants and other industrial atmospheres.

The new coating is self-priming and brushes out like oil paint with no sagging or dripping. It can be applied over bare metal, wood, masonry and most previously painted surfaces without special surface preparation, the company states.

Its mild odor and high flash point, 105 F, are said to permit application without interference with plant routines. Six colors are available.

Control Valve

Ross Operating Valve Co., is now offering a speed control valve with a screw driver slot. The new valve is also available with regular knob adjustment or pin lever adjustment.

The speed control valve provides split-second timing of piston movement by positive control of air flow. It can be mounted in any position, at either end or both ends of a cylinder to provide air flow adjustment.

The Ross speed control valve is designed for ease of adjustment and maintenance. It can be disassembled without breaking the line connection, and its construction is simple because the only moving part is the poppet.

Information can be obtained from Jack Neun, Marketing Mgr., Ross Operating Valve Co., 120 East Goldengate Ave., Detroit 3, Mich.

Packaged Steam Generators

Models SPH56-10B (10 hp) and SPH56-15B (15 hp) are junior additions to the "Steam-Pakette" line of packaged steam generators made by York-Shipley, Inc., York, Pa.

The new models may be fired by either light oil or gas, or by a combination of oil and gas firing. Both generators have 49 sq ft of heating surface and are available for high-pressure service only.

The new models are of two-pass construction, which requires no baffle to divert the flow of combustion gases. The minor reduction in overall boiler efficiency is said to be more than compensated for by the resulting lower cost, lesser weight and smaller size.

Because of the comparatively small volume of this boiler, the minimum plate thicknesses required by the ASME Boiler Code allow it to be rated at a maximum allowable working pressure of 150 psig, the firm states. With larger members of this line, the maximum pressure is 125 psig.

KEEP INFORMED

NEW EQUIPMENT
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Carbide Tipped Drills

Development of a new series of carbide tipped drills designed specifically for fast, efficient drilling in cast iron is announced by Ace Drill Corp., Adrian, Mich.

The new drills, designated Series 333, are manufactured with a special fluting, heavy web and slow spiral to provide greater tool strength and rigidity. The firm says the combination of a uniformly hardened ground-from-the-solid high speed steel drill body and a selected high grade tungsten carbide tip provides a drill that cuts cleanly, ejects chips readily and resists wear on the cutting edge. In addition, the new drills feature a specially designed point said to facilitate fast, easy penetration of the work.

The drills are stocked by 64ths in the $^1/_8$ to $^1/_2$ in. diam range and they will be made to standard jobber lengths. Descriptive literature and price information on carbide tipped and solid carbide drills, high speed steel drills, drill blanks and reamers are available from the company.

D-C Amplifier

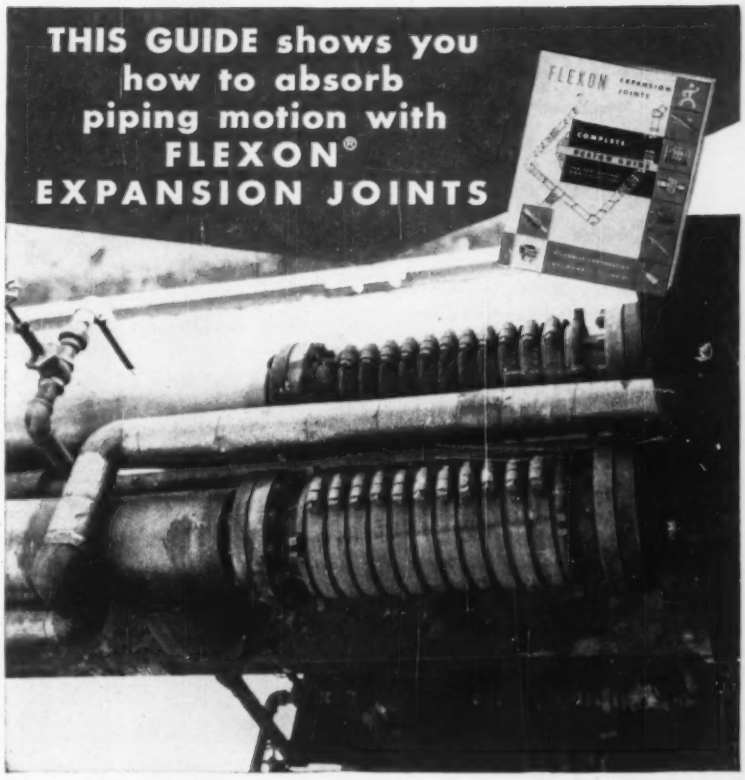
For use where maximum mobility and flexibility is desired, plus for those applications where limited space is a factor, a new multi-channel d-c amplifier unit has been developed by Brush Electronics Co., 3405 Perkins Ave., Cleveland 14, Ohio.

Called Model BL-536, the unit, which is mounted on a bench-top console 29$^1/_2$ in. high, consists of six completely interchangeable plug-in d-c amplifier sections, plus power supply, plus a six-channel oscillograph. The instrument is also available in a portable cart. It is particularly suited for such applications as computer readout or similar jobs, the firm states.

The amplifier unit features a measurement range from 0.050 to 400 v, has excellent zero line stability and a unique internal calibration system. It features a frequency response d-c 100 cycles.

The plug-in amplifier sections provide for expanding the system as desired up to the six-channel operation. Accompanying oscillographs offer a range of chart speeds, choice of ink or electric writing.

THIS GUIDE shows you how to absorb piping motion with FLEXON® EXPANSION JOINTS



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Complete specifications are given on all types of Flexon Expansion Joints. These units contain no packing, therefore require no maintenance. Wherever motion or misalignment is present in pipelines you can install Flexon Expansion Joints and forget them.

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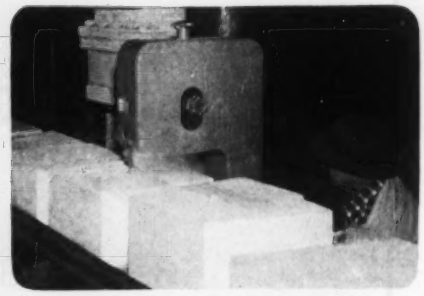
In Canada: Flexonics Corporation of Canada, Ltd., Brampton, Ontario



Compressors Make Dry Ice With New Economy

The Colorado CO_2 Corp. produces up to 50 tons of solid carbon dioxide daily in its $2½-million plant near Las Animas, Colo.

The gas, obtained from wells 5 miles away, is condensed, subcooled, and solidified at 109 degrees below zero F. with a new Frick-engineered cycle operating at very economical pressures.

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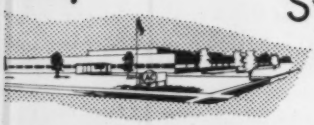

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KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

Automatic Gross Weigher

Automatic, distortion-free weighing of difficult adhesive materials is said to be provided by a newly designed gross weigher announced by Richardson Scale Co., Clifton, N. J. Automatic features of the scale include push-button control, automatic feed and bin level switches, and a choice of power feed mechanisms.

The new scale, called the E-52, feeds directly into a bag suspended from the weigh beam, rather than through a weigh hopper. This keeps material continuously in motion until it falls into the bag, eliminating material buildup and erratic discharge, the firm reports.

Besides handling such adhesives as carbon black, powdered sugar, powdered milk and starch, the new gross weigher will accommodate nonadhesive feeds, meal, food products, and chemicals. It handles 25-lb to 100-lb bags at normal operating speeds 5 or 6 bags a min. Accuracy is reported at an average of 1 to 2 oz.

The scale also has a headroom requirement of 3 ft, excluding feed arrangements, for installations where low headroom is a limiting factor.

Other features include dust-tight construction of weighing components and controls; a manually-operated dust-tight Universal bagholder; accessibility of all electrical and mechanical components for quick inspection and maintenance; and a choice of feeding arrangements, depending on the material being handled.

High Pressure Gas Filter

A high pressure gas filter which removes contaminates from gaseous streams and protects turbine expanders, compressors, pumps, nozzles and blowers in process industries has been developed by Purolator Products, Inc., Rahway, N. J.

According to the company, the resin-impregnated cellulose filter elements have a 99 per cent efficiency rating when tested with US Standard Test Dust (Fine) and are convoluted for extended area. The elements are protected for heavy duty application by an expanded metal outer cover and are contained in housings manufactured according to ASME Boiler and Pressure Vessel Code specifications. Each unit is engineered to the requirements demanded by the particular application.

One such unit, used in a liquid oxygen manufacturing plant, is designed for operating conditions of 3300 psi, 70 F and 7000 scfm of air. In this application, the firm says, the high pressure filter protects the turbine expansion equipment from abrasive dust which is carried over from the air drying system.

The filter units used in this operation employ double filtration, in which the air passes through two consecutive filter elements. The two elements are said to provide maximum protection against abrasive particles.

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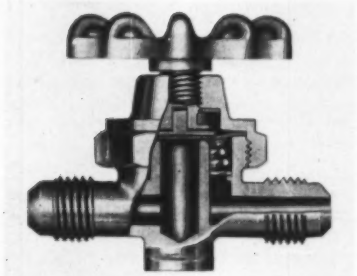


Packless Valve

A new small compact diaphragm packless valve engineered for unrestricted flow has been announced by Henry Valve Co., Melrose Park, Ill.

The new valve known as Type 515 with flare connections and Type 516 with ODS connections is recommended by the firm for refrigeration service, charging boards, gage shut-off valves and vacuum applications. The company says the valve also can be used to control of various industrial fluids that are hazardous and expensive.

They are available in 1/4 through 5/8 in. flare and ODS sizes, and can also be furnished with other types of end connections.

Other features of design include light weight, forged brass body with integral mounting flange, full capacity ports with inlet and outlet ports-in-line, nonrotating floating bearing plate, Teflon diaphragm, stainless steel spring, and hexagonal wrench grip on valve bonnet.

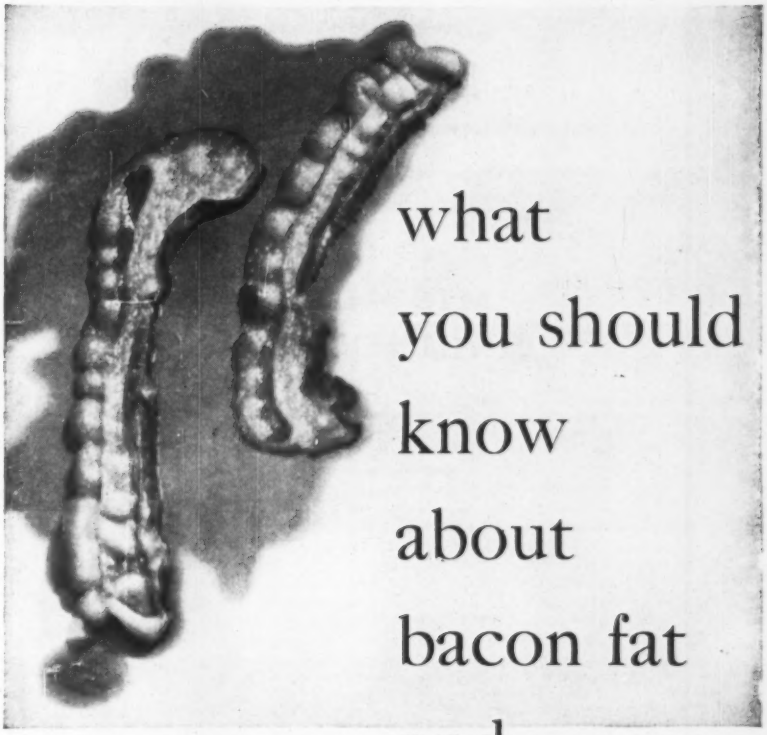
Reusable Hose Ends

Weatherhead Co., Fort Wayne Div., Fort Wayne, Ind., announces a new line of reusable hose ends identified as Model H-69. The new design is said to be particularly suited for use where medium high pressure, cotton covered, single wire braid hose is required.

According to the company compact design permits close coupling to conserve space. Threads match SAE and JIC standards.

Sizes in the new hose ends are as follows: Inverted male thread, 1/4 to 3/8 in.; female swivel, 1/4 to 2 in.; rigid male pipe, 1/8 to 2 in. Swivel nuts in the 1/4, 5/16 and 1/2 in. sizes will connect to either JIC 37 deg or SAE 45 deg fittings. In 3/8 in. size the 9/16-18 thread will connect to the JIC 37 deg and the 5/8-18 thread will connect to the SAE 45 deg fittings. Swivel-type end No. 8 is 14 pitch (AC811) thread.

The company says the line meets most requirements as original equipment or for field installations in such automotive and industrial applications as air lines, fuel lines, hydraulic lines, grease and oil lines, LP-gas transfer lines and transfer equipment, trucks and buses, materials handling equipment, construction and earth-moving equipment, off-highway vehicles.



what you should know about bacon fat and Albanene®

Here's the buying information you should have to get the *best* value when you buy tracing paper.

1. **The usual way** of "transparentizing" tracing papers is with waxes or mineral oils—much the way bacon fat makes a paper towel transparent. Eventually, these oily fluids "leak" out—leaving the paper opaque and useless for reproductions.

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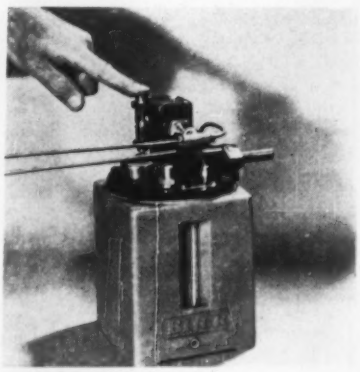
Computing Device

A new computing device that can be used in pneumatic measurement or control circuits for a variety of purposes is now being marketed by the Industrial Div., Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.

Called the Sorteberg force bridge, it can convert a transmitted signal from a square root flow transmitter into a linear signal, permitting the use of a flow receiver with an evenly graduated chart, the firms state. The device can be used to maintain a ratio between two pneumatic signals for flow ratio control. It can also be used to multiply, subtract, divide or square pneumatic outputs, or to provide pressure and temperature compensation for transmitted flow signals.

The company says design of the force bridge assures friction-free operation by the use of the feedback principle in a unique weighbeam and fulcrum system. The principal components are of plug-in construction, housed in a die-cast case.



Duplex Lubricator

Two independent lubrication systems, providing both cyclic and continuous oil flow to different bearings on the same machine, are now being built into a single automatic lubricator, according to an announcement made by Bijur Lubricating Corp., 151 W. Passaic St., Rochelle Park, N.J. The AP-3 lubricator is designed specifically for machines with a dual lubrication problem, where some bearings need periodic lubrication, others require oil continuously. Initially installed on a multiple spindle automatic bar machine, the lubricator can solve dual lubrication requirements on many machine tools, textile machines, printing equipment and special machinery, the firm reports.

The lubricator consists of two independent gear pumps with a common drive gear, mounted in a single housing, both drawing oil from a common reservoir in the bottom of the housing. Each pump has its own inlet (from reservoir) and outlet (to distribution line), feeding oil through separate distribution systems to the bearings each serves. At each

KEEP INFORMED

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lubrication point in the distribution systems a meter-unit filters and measures exact quantities of oil fed to each bearing.

The firm says the new system eliminates several problems presented by earlier lubricators that provided continuous and cyclic lubrication through a single pump, by means of a loading valve arrangement.

With the new lubricator, oil flow from the continuous branch is constant regardless of oil temperature. Both pumps are driven from the lubricator's drive shaft, which in turn may be powered from the drive of the machine it is lubricating.

Special by-pass valves on both cyclic and continuous branches can be manually adjusted to increase or decrease volume of oil discharge, if required. The duplex pump unit can be mounted in any of the company's standard reservoirs, offering several different designs to conform to machine requirements and a choice of 3- or 6-pt capacity reservoirs.

Molding Press Timers

All Baker Brothers automatic compression plastic molding machines are controlled by Cycl-Flex reset timers of the Eagle Signal Corp., Moline, Ill., according to a recent announcement.

Three synchronous motor-driven timers are built into the control panel. One is for controlling automatic breathe, up to 30 sec; the second for automatic reclose, up to 30 sec; and the third for cure, up to 5 min. Time settings can be made simply by turning a knob, the firm states.

According to the company, through simple timer settings and cam adjustments, the compression molding machines are instantly adjustable for close, decelerate, breathe, cure and open. Accordingly, the shortest cycle can be selected for any plastic molding job, to cut time and increase production. Automatic loading is also reported as quickly adjustable.

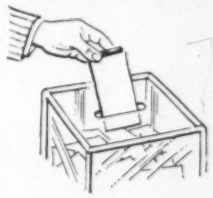
Sheet Steel Racks

Portable heavy duty sheet steel racks engineered to handle conveniently and store sheet steel has been developed by the Palmer-Shile Co., 12605 Mansfield, Detroit 27, Mich.

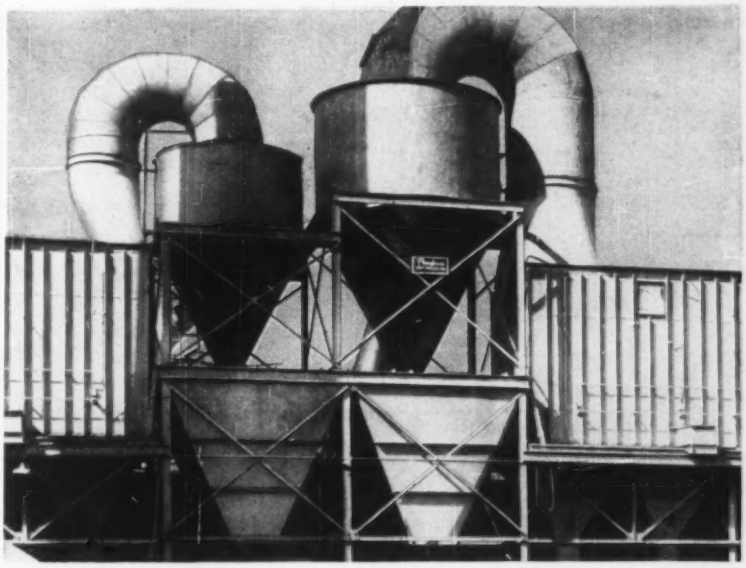
According to the company, an important feature of the new flush bottom racks are reinforced crossbars welded to the frame so the sheet steel stock can nest snugly. Sheet steel of various widths can be handled and tiered to desired height, the firm says, and each individual rack is easily accessible. The racks are designed to save floor space while permitting storage of more stock tonnage. Racks are picked up with automatic tongs suspended from overhead crane.

An extra thickness of lift bar is welded to the full wrap around crane bar for additional strength and safety. Safety strips are welded at each end of the rack to prevent rack from slipping when racks are tiered. Racks are built to any size and weight specifications.

Henry Chanin Corp. cast its ballot for Pangborn Dust Control



... and voted itself over $10,000 a year



The Henry Chanin Corp., East Point, Ga., is a processor of textile waste. To control the great quantities of dust released by the operations at this plant,[1] the firm uses four Pangborn Dust Collectors.

Today Pangborn Dust Control has almost doubled production at Henry Chanin by eliminating daily downtime that had been required for machine repairs.

Working conditions and quality of product are both improved. And, thanks to Pangborn, maintenance and labor costs have been lowered by over $10,000 a year!

Pangborn CONTROLS DUST

10D

How do you Vote?

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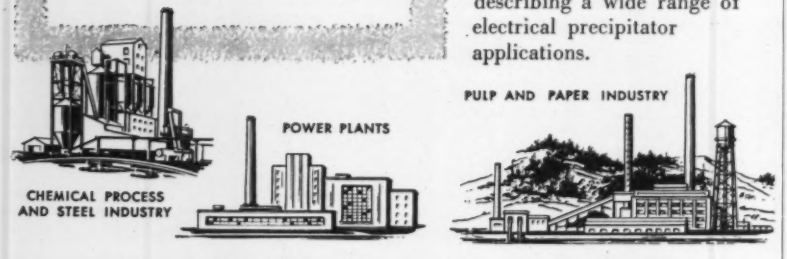

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Resin Adhesive

A new epoxy resin adhesive, said to be the only one of its type to meet government specification MIL-A-5090B has been developed by Minnesota Mining and Mfg. Co., Adhesives and Coatings Div., 423 Piquette Ave., Detroit 2, Mich.

The shear strength at bond temperature of 300 F is the greatest of any adhesive tested by the firm to date. In addition, it has exceptional resistance to water and salt spray, and can be cured with or without the addition of a catalyst, the company says.

Designated as EC-1469 the adhesive is described as being particularly well-suited for honeycomb applications because of self filleting properties that produce solid bonds between the honeycomb core and plate, lack of volatile components, and easy application. This adhesive can be used at service temperatures from − 65 F to 300 F.

Since no volatile by-products are given off during the cure, unperforated honeycomb material may be used instead of perforated type material. The adhesive can be cured either with or without an activator depending on the bonding temperature and properties required. Maximum strength bonds are obtained by curing without an activator at temperatures in the range of 350 F. For example, a $\frac{1}{2}$-in. 24ST3 alclad aluminum overlap bond that had been cured for 60 min at 350 F under 50 psi pressure produced an average shear value of 2760 psi when tested at a bond temperature of 300 F.

Although ultimate bond strength will be lowered, EC-1469 can be cured at a temperature of 200 F if an activator (EC-1470) is used. The lower strength is indicated by a 20 to 40 per cent drop in average shear strength of bonds tested at 300 F when compared with similar bonds cured without the activator.

The adhesive may be applied by knife, coating, spatula, notched trowel or flowing into place. Viscosity of the epoxy compound is generally affected by temperature. It handles well at temperatures from 75 F to 90 F.

Battery Separator

A battery separator material called Dynel-Mat has been announced by Felters Co., 210 South St., Boston, Mass.

It consists of a nonwoven fabric made with Dynel staple fiber, and was developed for the nickel-cadmium, alkaline type battery because it has exceptionally high resistance to concentrated caustic solutions. The firm says the material has excellent dimensional stability, and shows low electrical resistance.

As a replacement for less chemically resistant separators when immersed in potassium hydroxide, the material is said to provide durable, plate separation during the prolonged life of the new type battery. Its nonwoven structure permits effective screening action with minimum interference to internal current flow, the company says.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

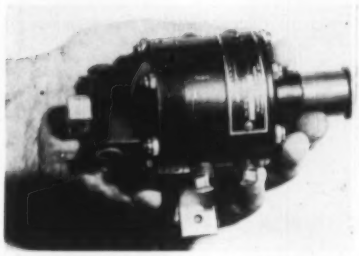
Universal Steam Trap

Perfecting Service Co., 332 Atando Ave., Charlotte 6, N.C., announces a new, small light-weight bucket type steam trap for unit heaters, small processing machinery and like applications in 1/2 in. pipe size, with a universal pressure range from 0 to 125 psi.

Developed for low pressure-high condensate rate applications where a smaller and inexpensive trapping unit is needed, the trap embodies the features of the firm's Unitrap line of steam traps.

According to the company, this line of traps is completely universal in pressure application, with faster warm-up, less wear, lower maintenance and capable of handling more condensate per hour without steam loss, manufactured in pipe sizes from 1/2 through 2 in.

The trap operates on a balanced pressure principle with a dual valve, which automatically compensates for differential pressures thru a range of 0 to 250 psi.



Differential Transmitter

Taylor Instrument Co., Rochester, N. Y., is introducing what it calls a new concept in low-cost flow transmission. Hitherto unchecked sources of steam, water and air in departmental consumption can be easily and economically cost-accounted with the firm's 200TD fixed range differential transmitter, the company states.

According to the firm, the new unit offers no barrier to control engineer the complete processes in a plant, including liquid level, consistency, or low-pressure air or gases up to 10 psi requiring sensitive transmission readings to an indicating or recording instrument.

The unit measures 6 1/2 × 3 in.; weighs 4 1/2 lb. It can be pipe mounted and all connections are 1/4 in. internal NPT. A wrench and screw driver can install and adjust it on stream for zero. Its diaphragm is neoprene-impregnated nylon. Body material is brass. Maximum working pressure is 150 psi; temperature 150 F. Air supply pressure is 20 psi. Air consumption is 0.10 standard cfm, and output pressure is 3 to 15 psi.

Calibration accuracy is said to be better than 1 per cent, and sensitivity exceeds 0.1 per cent. Ranges: 0 to 50, 100, 200 and 300 in. of water.

FIGHT VIBRATION WITH VIBRATION

Shaker system for complex motion tests

NEWEST TECHNIQUE in environmental testing is complex motion testing. It comes closest to reproducing actual vibrational environments encountered in operation of missiles, aircraft, vehicles.

An MB Vibration Exciter System designed for such service is one of optimum versatility. It fulfills not only the special needs of *random motion testing*, but virtually any other test specification as well . . . such as sinusoidal motion testing, fatigue testing, automatic cycling, and provisions of MIL-E-5272A.

HEART OF THE SYSTEM—THE EXCITER

The MB Model C-25HB (shown) is rated at 5000 pounds peak force. Its table assembly is unusually stiff to reduce resonances yet weighs only 75 pounds. Axial resonance lies well over 2000 cps operating range.

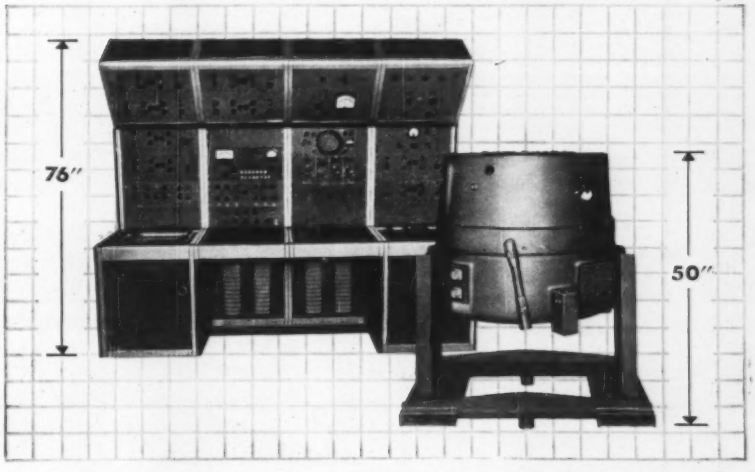
This and other MB Exciters for 200, 1200, 1700, 3500, 7000 and 15,000 pound force faithfully reproduce complex input signals when teamed with an MB amplifier and compensation console.

MATCHED PERFORMANCE

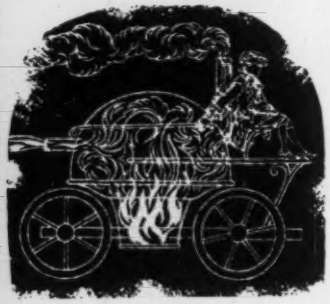
Other elements of the system are integrated with the exciter's high performance. An electronic *amplifier* fulfills the power demands. A control cabinet houses all necessary *instrumentation* plus frequency and amplitude *controls*. Circuits in a *compensation console* give automatic adjustment so that table acceleration remains proportional to input voltages. A top quality tape recorder for playback of the complex wave patterns may be used.

If you have any questions on vibration testing at all, come to a leading authority on the subject . . . the MB engineering staff.

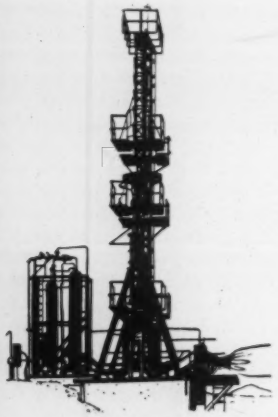
MB *manufacturing company*
A DIVISION OF TEXTRON INC.
1060 State Street, New Haven 11, Conn.
HEADQUARTERS FOR PRODUCTS TO ISOLATE . . . EXCITE . . . AND MEASURE VIBRATION



MECHANICAL ENGINEERS



Stimulation, status, security . . . the absorbing challenge of the rocket propulsion field, the rewards of professional recognition, the stability of a firmly established organization . . . are yours at Aerojet-General.



Aerojet offers experienced mechanical engineers and recent graduates unparalleled career opportunities on a variety of important problems.

Design and development of pumps, valves, control and propellant systems for huge new liquid-propellant rocket engines.
Design and testing of a variety of thrust chambers, turbines, injection systems, and servomechanisms.
Studies of ignition, combustion phenomena, heat transfer, cooling, vibration and thermal shock.
Design and development of thrust reversers for jet engines.
Design and testing of underwater jet engines and other devices.
Design of test equipment and production machinery.

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Write: Director of Scientific and Engineering Personnel, Box 296BB, Azusa, Calif. or Box 1947BB, Sacramento, Calif.

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NEW EQUIPMENT | BUSINESS NOTES | LATEST CATALOGS

Expansion Joints

Badger Mfg. Co., 230 Bent St., Cambridge, Mass., is now offering a redesigned line of packless corrugated expansion joints for use in power, heating, industrial and process piping applications.

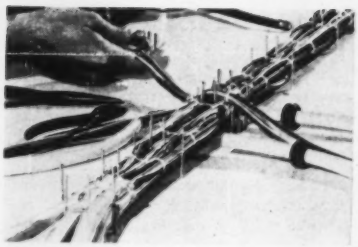
The joints, known as service-rated expansion joints, incorporate the first basic expansion joint design changes to be made in recent years by the firm that held many of the basic patents on these devices.

The new joints are available in several types which are classified in series according to the pressure-temperature conditions to be encountered in much the same way that pipe flanges are rated by the ASA. Joints in Series 50 are for lower line pressures while joints in Series 150 and higher are for higher pressures.

The most notable design change in Series 50 expansion joints is found in the shape of the corrguations which form the flexing member. The radically different design is based on a correlation among height, shape and pitch dimension which was established as a result of extensive testing of corrugation shapes by the firm. According to the company, the new shape gives each corrugation a more effective height which results in greater flexibility and therefore more uniform movement per corrugation than conventional types of expansion joints. In addition, the new corrugation naturally assumes an all-curve shape under operating pressures and temperatures and actually "breathes" with pressure fluctuations, the firm states.

Joints of Series 150 and higher also have the improved corrugation shape found in Series 50 joints. However, because these joints are designed for use where there are higher line pressures, they also have reinforcing rings. The tubular rings make metal-to-metal contact only in the "valley" of each corrugation. This design maintains the hoop dimension of each corrugation and allows it to naturally assume an "all-curve" shape when under line pressure.

Fabricated from wrought steel, the new reinforcing rings are substantially lighter and are able to withstand higher pressures and temperatures than conventional cast iron types. All joints are available in any weldable alloy including stainless steel, Monel, Inconel and nickel for pipe diameters from 3 to 72 in. They are normally equipped with internal liners which streamline the flow through the joint.



Harness Board Nails

John Hassall, Inc., Westbury N. Y. announces a new line of nails designed specifically for harness board wiring applications.

The nails, or posts, have a collar-type stop $^5/_8$ in. from the pointed end to prevent them from being driven in too far. The collar also acts as a guide in assuring that they will be driven in far enough. The posts are driven directly into the board without the aid of pre-drilled holes. Tops are milled round to facilitate slipping wires on and off the harness. Nails are made of corrosion-resistant cadmium-plated steel and are available from stock in above-collar lengths of 1, $1^1/_2$, 2, $2^1/_2$ and 3 in.

A typical electronic application is shown in the photograph. The nails are being utilized as harness board posts to hold the assembled wires in place according to the circuit diagram laid out on the board.

Mechanical Seal

A new boiler feed pump mechanical seal, developed by Crane Packing Co., Dept. MXN Morton Grove, Ill. is now available. Once installed, the company claims, the seal needs no further attention, and replacement of expensive sleeves is eliminated. There is no leakage, the firm says.

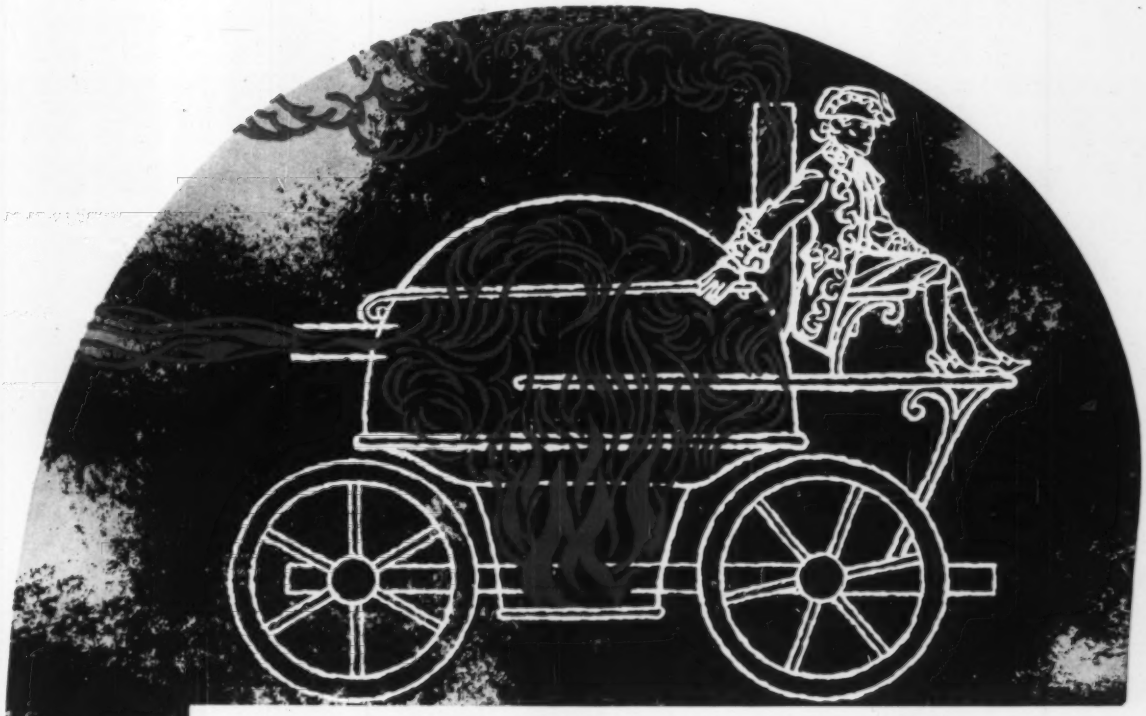
According to the company, long seal life is obtained through the use of a special closed circulating system. This engineered system provides cool water in sealing chamber assuring best seal performance.

The new seal comes fully engineered for the particular operation, including adaptation to pump design and piping arrangement. Plans are furnished. Recommendations are supplied and heat exchanger size is specified.

Continued on Page 52

Let's Finish the Job!

JOIN THE MARCH OF DIMES IN JANUARY



s'Gravesande's Stoomwagen

s'Gravesande's Steam Reaction Car

In 1721 Jacob Willem s'Gravesande of Delft, stimulated by the recently enunciated Third Law of Motion, astounded the Royal Society by constructing a practical steam reaction car. The vehicle actually moved several times its own length, a distance of about two meters.

In 1956 the goal is no longer meters, but hundreds, and even thousands, of miles. Aerojet-General Corporation, leader in American rocket propulsion for more than a decade, is proud to participate in man's first assault on the frontiers of outer space—Project Vanguard.

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Aerojet-General invites scientists and engineers—men of imagination and vision—to join the attack on the most significant research, development and production problems of our time.

57 VARIETIES boiled down

L. A. Edwards

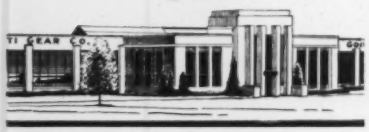
ASST. SALES MGR., THE CINCINNATI GEAR CO.

We could pass ourselves off as the Heinz of the Gear Industry by naming at least 57 different varieties of gears that we manufacture — but to be more concise, the gears we produce can be listed in eleven *basic* categories: spur, helical, rack, worm, herringbone, bevel, spiral bevel, internal, sprocket, Zerol* and Coniflex* (*Reg. U.S. Pat. Off.). This is still a pretty impressive list, we think, and covers just about all types in current demand for industrial use. Of course there are many variations within these basic types, too — such as a hypoid gear, which is basically a spiral bevel gear.

If you're one who has always thought that "gears is just gears," it will pay you to find out just what advantages each of these types has to offer. For instance, a straight bevel gear might perform *adequately* in an application that *ideally* calls for a Zerol gear; but fine points such as this can make the difference between *adequate* and *superior* results from your product. Your Cincinnati Gear Representative can cite advantages for the different gear types, and perhaps give you some ideas for applications in your products that you may have overlooked. And after the "right" gear has been chosen for your application, we can produce it for you — not only the right *kind* of gear, but with the "right" *quality* and *service* to assure your becoming another of our many satisfied repeat-order customers.

THE CINCINNATI GEAR CO.
CINCINNATI 27, OHIO
"Gears—Good Gears Only"

CINTI ®



KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

Instrument Motors

An improved line of sub-fractional horsepower motors for precision instruments has been announced by Borg Equipment Div., George W. Borg Corp., Janesville, Wis.

The new motors are offered in a range of from $^1/_{2000}$ to $^1/_{750}$ hp and are available in both synchronous and induction types, with or without gear trains.

The manufacturer states the new motors offer exceptional ruggedness and dependability. They are designed for quality instrument application and find wide use in the industrial TV, recorder and instrument fields.

End bells and gear train cases are die-cast alloys, precision machined to form a totally enclosed housing. Geared output shafts have two heavy bearing supports to accommodate radial loading. All gears are precision hobbed. The die-cast rotors are mounted on ball bearings for longer life and continued accuracy.

Rotary Joint

Development of a new, compact, improved type of rotary joint suitable for use on steam, air, water, oil, gas, or alternating hot and cold service is announced by Barco Mfg. Co., Barrington, Ill. Designated as Type C, the new joint is designed to simplify selection specifications by being almost universally suitable for pressures from 0 to 200 psi, steam, or to 400 psi, hydraulic; for temperatures to 450 F, or special to 500 F; and for any ordinary rotating speed. Type C is also suitable for either single flow or two-way syphon flow installation. It is now being produced in eight standard sizes from $^1/_2$ to 3 in.

Barco Type C joints are characterized by low starting and running torque, even at high pressures; thus, power requirements are low. Bearings and seal are self-lubricating and the seal is self-adjusting for wear, eliminating any need for periodic take-up on packing or stuffing box.

A considerable number of Type C joints are already installed on a variety of services and it is expected they will have wide application on textile, paper, rubber, printing, chemical, laundry, food processing and metal rolling machinery where steam, water, or other fluids is piped into rotating drums, dryers or rolls.

Compact construction has been achieved without sacrifice to long bearing support which has been characteristic of Barco design. Overall length ranges from $5^7/_8$ in. in the $^1/_2$-in. size to $12^3/_4$ in. in the 3-in. size. Body construction is malleable iron with heat treated steel rotating shaft. Joints are available with choice of right hand or left hand thread on the rotating shaft.

Complete information about the Type C rotary joint is contained in new Barco Catalog No. 310. Interested readers may obtain copies by addressing requests to Barco Mfg. Co., Dept. J-36, 500 Hough St., Barrington, Ill.

CANCER LIFE-LINE

In factories, plants and offices across the nation, the line is busy. Through films, pamphlets, posters, exhibits and lectures, the life-line of cancer education is reaching more and more men and women in business and industry.

All of us are concerned with the major threat which cancer poses. Today, thousands of lives are being saved each year, but many more would be saved if people went to their doctors *in time*. This, and many other facts of life about cancer, are part of the education program which the American Cancer Society offers you in your plant or factory. For additional information, call the American Cancer Society office nearest you, or write to "Cancer" in care of your local Post Office.

AMERICAN CANCER SOCIETY ®

KEEP INFORMED

NEW EQUIPMENT
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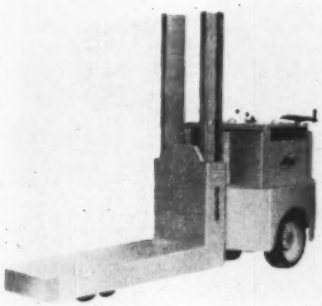
Relief Valves

Milton Roy Co., 1300 E. Mermaid Lane, Philadelphia 18, Pa., has announced the availabilitiy of its new line of relief valves and back-pressure valves which can be used with corrosive fluid at pressures to 1500 psi and temperatures to 250 F. The top works of these valves are protected by Kel-F thermoplastic diaphragms, the firm says.

Available in standard 1/4-, 1/2-, 3/4-, and 1-in. sizes, the valves offer a wide range of pressure settings which are easily made with a screw driver. Valve bodies are constructed of cast steel, 316 stainless steel, Carpenter No. 20 and Hastelloy C.



High-Lift Truck

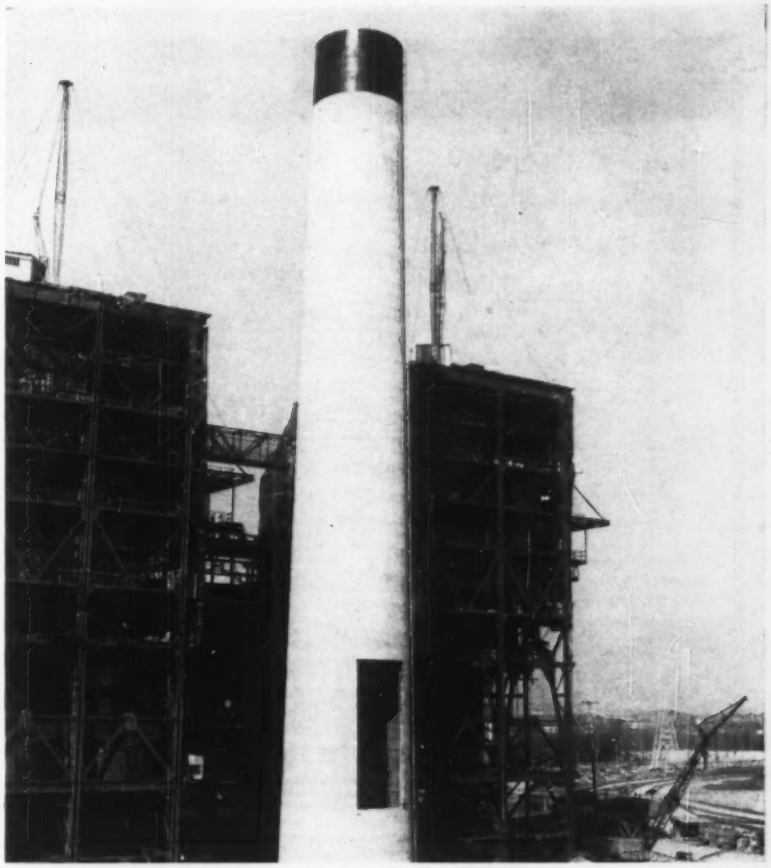
A new 10,000-lb capacity, electric powered high-lift platform truck, designed for general rugged handling operations, has been developed by Elwell-Parker Electric Co., 4205 St. Clair Ave., Cleveland, Ohio.

Known as the E13-10, the new truck features two-wheel drive, six-wheel steer, is hydraulically actuated, and is of the end-control, stand-up, nontelescopic type.

The new model has a frame built of heavy steel plate formed and electrically welded. Center sill type construction is used, with all major units attached directly to the heavily reinforced alloy steel bars which form the sills.

The drive motor is connected directly to the single reduction worm and wheel with integral differential. Equal length, full floating drive shafts are splined to the differential housing at one end and to drop forged, universal steering joints at the opposite end. The universal joint is in turn splined to the drive wheel clutch plate which is doweled and bolted to the drive wheel.

A hydraulic lift cylinder is used to operate the platform lift. A separate electric motor with an integral hydraulic gear type pump supplies the lift cylinder, and the system operates at pressures below 12 psi. A check valve is built into the lift cylinder to prevent sudden dropping of the lead should the system rupture at any point. An automatic unloading device prevents damage when the platform reaches its limit of travel or in the event it strikes an obstruction.



CONSOLIDATED builds both large and small CHIMNEYS!

This huge chimney is only one of the three required for a modern generating plant with tremendous electrical output . . and Consolidated designed and built it. Not the largest chimney in the world, but a tremendous job nevertheless; skillfully executed to the complete satisfaction of general contractor and operator.

The chimney is 250 ft. high with a top inside diameter of 24 ft. and a bottom outside diameter of 36 ft. 9¼ in. It is of reinforced concrete construction built to withstand earthquake stresses with a brick lining the entire height. The air space between the lining and the concrete shell is insulated with fibreglass. A hopper is located within the chimney at the base. Weight of chimney is 1910 tons . . still another example of Consolidated's engineering and construction skills, and the adaptability to meet the most exacting requirements.

Consolidated has designed and built chimneys of all types and all sizes in the United States, Canada, Mexico and South America—Perforated Radial Brick, Reinforced Concrete, Face and Common Brick—Acid Proof; High Temperature. It installs linings for steel stacks, waterproofs, rebuilds and repairs; installs lightning rods and aircraft warnings; demolishes chimneys. Whatever your chimney problem may be, Consolidated has the experience, the knowledge. and the skilled personnel to handle it.

Free Inspection Service A Consolidated engineer will inspect your chimney at no inconvenience to you and make recommendations for increased life and efficiency when necessary This service places you under no obligation.

Phone, wire or write today for information. Ask for catalog giving installations, engineering service and chimney design data

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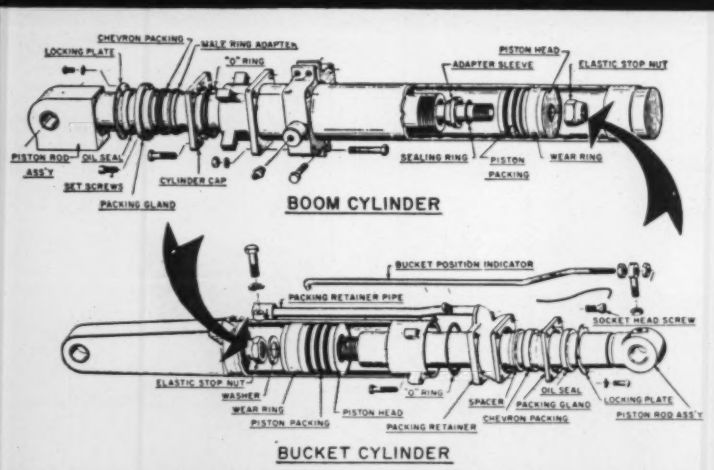
FASTENER PROBLEM



How to retain hydraulic piston rods better–and cheaper

The Frank G. Hough Co. were using castellated nuts and cotter pins to retain the piston rods in hydraulic cylinders (shown above) installed on their earth moving equipment. There were four nuts per cylinder and two cylinders per machine. Cross-drilling was required for the cotter pins used to lock the slotted nuts. This added to the cost of the fastening, and insertion of the cotter pin was one more labor operation. The problem was to reduce costs and, if possible, improve the performance of the fastener.

A standard nylon insert Elastic Stop® nut was tested and ultimately approved. Shop trials showed they cut costs on the "Payloader" because they are simpler and less expensive to assemble–and final adjustment is far more precise than was ever possible with cotter pins. Two years of field testing gave convincing proof that stop nuts held fast under vibration and stress. The nylon locking insert is almost impervious to wear and guarantees extended reusability–making cylinder maintenance simple and economical . . . no matter how frequent it may be. Elastic Stop nuts are now in general use on all "Payloader" equipment.

MAIL COUPON FOR DESIGN INFORMATION

ESNA

Dept. N17-1211 Elastic Stop Nut Corporation of America
2330 Vauxhall Road, Union, New Jersey

Please send me the following free fastener information:

☐ Elastic Stop Nut bulletin

☐ Rollpin Catalog

☐ Here is a drawing of our product. What self-locking fastener do you suggest?

Name_____ Title_____

Firm_____

Street_____

City_____ Zone____ State_____

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NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Vacuum Pumps

NRC Equipment Corp., 160 Charlemont St., Newton Highlands 61, Mass., has announced the introduction of Series 4700 mechanical booster vacuum pumps for industrial high vacuum processes.

Available in six sizes from 1000 to 12,000 cfm, the new pumps operate at top capacity throughout the pressure range of 5 to 2200 microns, in which large amounts of gas are evolved in such varied operations as freeze-drying, vacuum melting and heat treating, impregnation and dehydration.

The Series 4700 do not use oil either as a pumping medium or as a sealant in the high vacuum system.

Toggle Action Clutch

A unique type clutch, possessing an exclusive "lock-in" toggle action, is now offered by Salsbury Corp., 1161 E. Florence Ave., Los Angeles 1, Calif.

Called the Tog-O-Log clutch, it has a disengagement speed approximately 400–500 rpm lower than engagement speed. The manufacturer describes this as a decided advantage over the ordinary centrifugal clutch, on which pick-up and release speeds are approximately equal. The wide differential allows the engine to idle at a satisfactory speed without slippage at relatively low operating speeds, and provides for a greater load capacity in proportion to clutch weight.

The new clutch is available for use on gasoline and diesel engines in the 10–50 hp range.

4-Way Air Valve

Barksdale Valves, 5125 Alcoa Ave., Los Angeles 58, Calif. announces the addition to its line of a new $1^1/_2$ in. 4-way valve for 0 to 250 psi service.

The valve incorporates the firm's 'Shear-Seal' principle, which consists essentially of a pressure-balanced, self-aligning tubular sealing ring in constant perfect contact with an optically flat porting disk or rotor containing the flow passage.

Non-corrosive materials are used for all valve parts. The shaft and detent ball are stainless steel, valve body and housing are aluminum.

KEEP INFORMED

NEW EQUIPMENT
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Bonding System

A system of bonding rubber to metal claimed as a means to savings of hundreds of dollars in production costs has been announed by the Adhesives Div., B. F. Goodrich Industrial Products Co., Akron Ohio.

Called Duolock, the new system that combines a primer with appropriate tie coats, costs less per gallon than other bonding systems, the company states. It may be used on motor mounts, industrial tires, rubber covered rolls, printing and typewriter rolls or wherever rubber materials, both natural and man-made, are bonded to metal, the firm says.

Extensive testing of the system has revealed that superior bonds may be obtained over a wide range of curing conditions such as long low temperature cures or short high temperature cures, according to the company.

The rubber company also announces that its technical service will help firms select exactly the right adhesive to combine with the primer for dependable results.

Duolock primer is a free flowing, single phase, black liquid supplied at a viscosity of 95 centipoises with a solids content of 22 per cent, suitable for brushing as supplied. Samples, literature and prices of the system are available from the company.

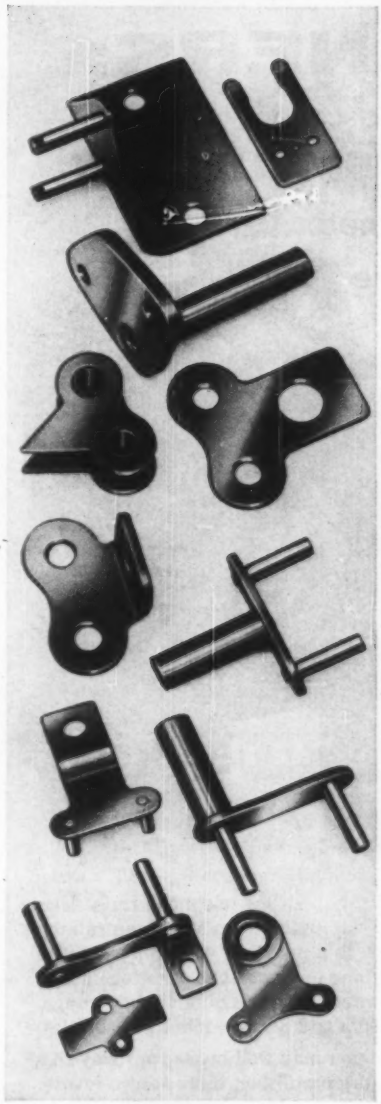
Personnel Elevator

What is described as a completely new concept in construction and industrial personnel elevators has been introduced by Hawkeye Products Corp., Syracuse, N. Y. This unit is said to be the first and only type of demountable, approved passenger elevator and it takes the place of a permanent elevator installation which heretofore was required in many states to transport personnel during construction, maintenance, repairs and for industrial use. Its many safety features meet, and in most cases, surpass codes and ASA specifications, the company says.

This elevator, operating on a vertical monorail, has a 2000 lb capacity. The firm says the unit is simple to set up and operate and can be quickly disassembled and moved to another location and re-erected in a short time. The company states that the unit will find practical application in large industrial plants as a semipermanent personnel and materials handling unit which can be mounted outside of a building.

The elevator can also be set up in a pit or shaft carrying men or materials to and from below ground level. With the addition of a stabilizer bracket about every 15 ft, the elevator is said to be practical for almost every industrial use and height. A modification of the standard elevator is available to provide a complete explosion-proof unit.

A double-grooved pulley on top of the monorail column carries the two steel hoisting cables as they lift the elevator car. A cable equalizer maintains equal tension on the two



Acme
SPECIAL ATTACHMENTS
provide great versatility for
CONVEYOR CHAINS

Acme Precision conveyor chains are easily adapted to special requirements by the use of stock or specially designed attachments. Possibilities for modification of Acme standard chains are practically endless. In all adaptations, Acme engineers are skilled in retaining as many standard parts as possible to reduce costs.

Most attachments are in reality special plates which take the place of standard chain plate and are stamped from dies in production quantities. Attachments in smaller lots can be hand machined, cast, bent or welded to your specifications.

Whether you use a simple extended pin design or more elaborate attachments used for timing and motioning special conveyor lines, Acme engineers are ready to design practical applications for you.

All Acme conveyor attachments available in stainless steel for the packaging and food industries. Write our engineering department.

FREE CHAIN CATALOG

Write Dept. 11-G for your 80-page copy of Acme's latest catalog. Packed with valuable chain data. An indispensable chain reference.

Call ACME for Service

Acme Chain Corporation
HOLYOKE
MASSACHUSETTS

DESIGNERS:

A profitable career at

PRATT & WHITNEY AIRCRAFT

may be as near

as your **telephone**

The telephone rings. You pick it up and begin talking with a man you've never met. You ask a number of questions — important questions about career opportunities, pointed questions about salary range, work assignments and advancement possibilities.

When you put the receiver down, you may well be on your way to a more challenging, more promising, more secure future.

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Pratt & Whitney Aircraft, East Hartford, Conn.

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☐ Structures ☐ Valves ☐ Test Equipment
☐ Afterburners and Related Equipment ☐ Heat Exchangers and Combustion Problems ☐ Test Rigs

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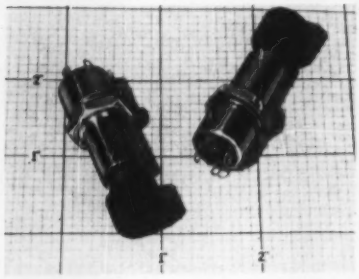
hoisting cables and trips a safety locking device should either cable stretch abnormally or break. The safety locking device, a positive cam-action brake, stops the elevator within one quarter of an inch, and holds it there even while fully loaded. Passengers or materials are not jolted by stopping and starting, due to anti-friction rollers on which the car travels. Three main bearings and seven guide rollers assure smooth action.

Other safety factors include a safety limit switch that is actuated when the car reaches the top or bottom of limit of its travel; an automatic limit switch which prevents movement of the elevator unless both gates are closed and latched; a governor which automatically stops the car if it overspeeds for any reason; continuous-operation switch buttons at the control station that automatically stop the car when pressure is removed from either "up" or "down" button.



Pushbutton Switch

A slim new pushbutton switch for computers, calculators, and similar electrical and electronic devices using whole banks of adding machine-type key switches has been announced by Hetherington, Inc., 1200 Elmwood Ave., Sharon Hill, Pa.

Known as the Type B5023, the new momentary-contact switch is said to have a smooth, yet precise, nonsnap action that closely approaches the speed of operation, convenience, and general feel of mechanical-type pushbuttons used on calculating machines. The switch responds to an operating pressure of only $\frac{1}{2}$ lb and has a total button travel of $\frac{1}{4}$ in. Contact arrangement is 2-circuit, break-before-make.

The entire switch mechanism is housed in a dust- and moisture-resistant anodized aluminum case $\frac{9}{16}$ in. in diameter. This is the same diameter as the button so that switches may be grouped closely together. Total length, including button is $2\frac{1}{16}$ in. Special key-type button caps are available in a variety of colors and styles, many engraved with a letter, numeral, or symbol. The switches are designed for a life of over 100,000 cycles at rated load of 28 v, 3 amp.

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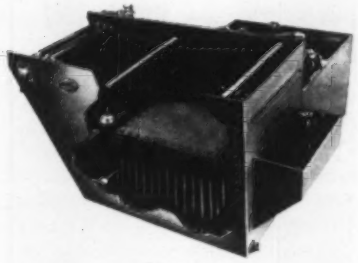
Fireproof Panels

Two testing laboratories' seals of approval are heat-bonded into each translucent panel of "Fire-Snuf," a special fire-retardant structural plastic panel manufactured by the Resolite Corp., Zelienople, Pa. The labels are those of Underwriters Laboratories, Inc., and of Factory Mutual Laboratories.

Structural plastic panel, the firm states, is used industrially in the wall daylighting and skylighting of buildings. "Fire-Snuf" is currently the only Fiberglas-plastic panel carrying both approvals, the company says.



Tubular Screen Filter

Industrial Filtration Co., Dept. FM-200, Lebanon, Ind., announces a tubular screen type filter designed for more efficient filtration and maximum flow capacity of coolants, cutting oils and all liquids requiring removal of minute particles.

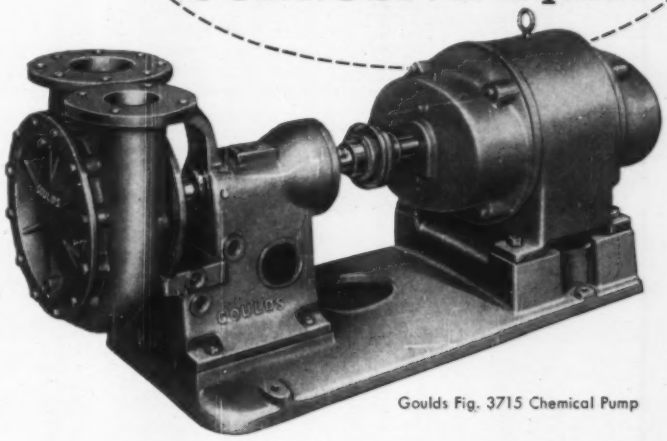
Small diameter screen tubes are manifolded together into a common suction header through which the sludge laden liquid is drawn by a special multiple chamber valve and pumped into a filtered liquid compartment. As the screen deposits reduce the liquid flow through the screen tubes, the unfiltered liquid level begins to rise. At a predetermined level, a float actuates a switch controlling the multiple chamber valve, reversing the flow of the liquid.

The reversed flow backwashes accumulated deposits from the screens. As the reverse flow of clean liquid causes the unfiltered liquid to continue its rise, the float again reverses the flow of liquid through the valve, returning to the filtering cycle.

Sludge removed from the screen tubes drops to the bottom of the filter compartment where it is removed by chain driven dragout flights.

When precoat is used, an automatic measuring device with a vibrating mechanism to prevent bridging of the precoat material is mounted above the filter inlet and automatically feeds a predetermined amount of precoat material at each backwash period. This precoat feeding device is actuated by the air cylinder feed which operates the multiple chamber valve. This automatically adds new precoat at the same time the old precoat is backwashed from the tubes.

Here's a pump especially designed for your ABRASIVE and CORROSIVE liquids



Goulds Fig. 3715 Chemical Pump

You minimize your "hot" pumping problems — and expenses — with Goulds chemical pumps because *they're built to take it!*

With the Fig. 3715 pump, you can handle liquids that would "murder" most pumps. Such liquids as acid, alkaline liquor, hot size, and slurry. But this pump offers more than just severe service design. You get fewer maintenance problems plus special operating advantages.

For example

Look at the support head—its rugged, box-type design with water jacket permits you to pump liquids as hot as 350° F. Over-lubrication is prevented by grease-lubricated standard bearings with grease relief. You can adjust impeller clearance without any dismantling by means of a simple, positive external arrangement.

A variety of construction materials meets every need. Goulds Fig. 3715 pumps come in Type 316 and Gould-A-Loy 20 stainless steel, all aluminum-bronze, all iron or bronze-fitted.

More reasons why

There's a wide range of sizes, too—nine in all—with capacities up to 720 GPM and heads to 200 feet. You can keep a low spare parts inventory since many of the parts are standardized for interchangeability between sizes.

There are many more reasons why you can save money and avoid maintenance headaches by pumping those harsh liquids with a Goulds Fig. 3715 pump. Learn about them by addressing your inquiry to Goulds Pumps, Inc., Seneca Falls, New York.

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Cam Limit Switch

A new rotating cam limit switch with 15-amp contacts, designed to facilitate precise synchronization of multiple operations, has been developed by the Clark Controller Co., Cleveland 10, Ohio. The switch features a positive micrometer screw adjustment of each individual switch mechanism in relation to its cam. This adjustment can be made with a screwdriver, from the outside, while the switch is in motion.

The Clark Bulletin 102 Type "AL" cam limit switch is made in three standard sizes accommodating up to five, nine, or twelve cams. The split butterfly cams can be set with a spread between circuit make and break of from 15 to 345 deg, and the external in-motion adjustment of ±15 deg makes possible micro-adjustment while equipment is in motion.

Contact assemblies may have two sets of contacts, one normally-closed and the other convertible—either normally-open or normally-closed. Contact operating arms bearing on the cams have nylon rollers which virtually eliminate wear. Both fixed and moving contacts can be inspected from the outside through a transparent panel in the oil-tight case.

Cams are individually adjustable and removable without disturbing other cams. Contacts can be removed and replaced without disassembling the switch.

The switch is designed to operate at speeds up to 100 rpm, and rotation can be either clockwise or counter-clockwise. It also features an aluminum case, cadmium plate on all steel parts, double shaft extensions, and permanently-lubricated anti-friction shaft bearings which absorb thrust as well as radial loads.

Teflon Plug Stopcock

Fischer & Porter Co., Hatboro, Pa., has developed a new stopcock which requires no stopcock grease, replacing the customary glass plug with a precision-machined Teflon plug.

The unique, self-lubricating property of the Teflon provides "non-freezing" operation while maintaining a leakproof seal, the firm states.

According to the company, the possibility of product contamination due to stopcock grease is completely eliminated. The stopcock, named Lab-Crest, is said to operate smoothly over a wide temperature range. The Teflon plug is held securely in place by a Kel-F nut and canot loosen during use. The firm says this construction makes it ideally suited for pressure applications and handling of hazardous liquids. Normal vacuum applications can also be handled with the new stopcock.

The barrel and sidearms are fabricated from Pyrex brand glass. Since all construction materials are chemically inert, strong cleaning solutions can be used without fear of parts corrosion.

BINDERS

For Your Codes and Standards

These Binders are well constructed, open flat; hold the publications firmly; and permit insertion, removal and transposition of contents easily. They are made of durable cloth, have identifying title stamped on the spine, and are 9" x 12" in size.

The Binder for the ASME Boiler and Pressure Vessel Code has a four inch capacity and is equipped with twelve flexible steel rods. That for Standards and Codes has a three inch capacity and holds from twenty to twenty-five pamphlets.

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Automatic Counting

A new line of highly accurate automatic counting devices for any operation controlled by pneumatic or hydraulic action has been announced by Pneumaticount, 3400 N. E. 54th Ave., Portland, Ore.

The new counters screw into the line controlling any air or hydraulic cylinder and can be completely installed in only five minutes, the firm states. There is no linkage to assemble or get out of adjustment, no solenoid; and no possibility of half or miscounts, according to the company.

Models are available for from 1 to 5000 lb and up to 300 counts per min. All models are available with five or six digits and knob or key reset.

Fog Nozzles

A new line of hard rubber fog nozzles has been announced by Bete Fog Nozzle, Inc., Greenfield, Mass.

The new nozzles are claimed to be nonclogging, corrosion resistant with practically any spray, longwearing and inexpensive.

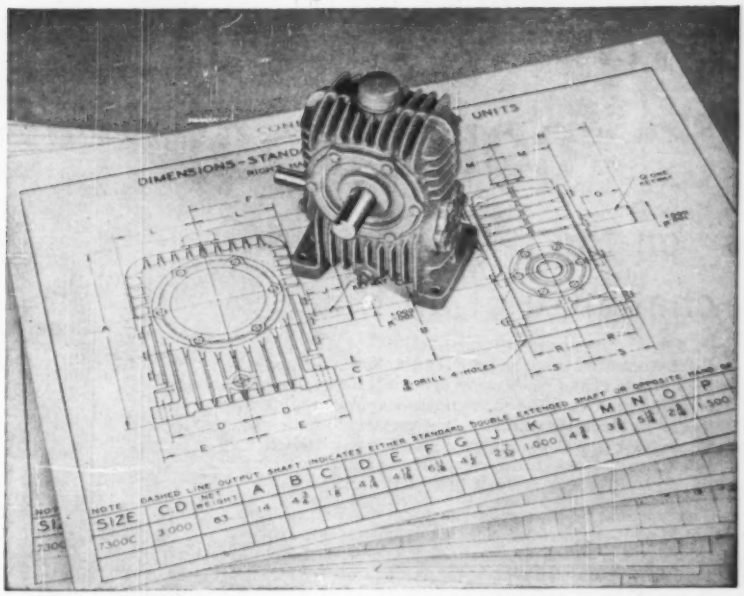
Because of their immunity to most chemical substances, these hard rubber nozzles are claimed to be ideal to use where corrosive conditions make the use of metal impractical and where nozzles of other nonmetallic material are unsuited because of chemical properties, high temperature or cost.

The new HR series nozzles also utilize the manufacturer's exclusive spiral design and are of one piece, nonclogging construction. They are available in ten models with narrow angle (50 deg) or wide angle (120 deg) hollow cone spray pattern in five different flow rates from 5 to 50 gpm. The thread connection for the smaller sizes is $^3/_8$ in. male pipe thread, $^1/_2$ in. male pipe thread for the larger sizes.

Brass Gate Valve

Model No. 101 non-rising stem brass gate valve, intended for use on highly competitive plumbing and heating installations, is being introduced by Milwaukee Valve Co., 2375 S. Burrell St., Milwaukee, Wis.

The valve is a streamlined version of the firm's heavy duty type valves. Specifications and capacities are 125 lb, SWP; 200 lb WOG. It is the non-shock type with solid wedge disk and brass construction.



DIMENSIONS ONLY TELL HALF THE STORY...

. . . about worm gear speed reducers. You've got to compare size with load capacity for the whole picture. Inside a Cone-Drive speed reducer you'll find the double-enveloping worm gear design that makes it the most efficient right-angle speed reducer available.

Take the standard 3" center distance unit above for example. Here are its Class I Service Ratings with a 5:1 reduction:

Worm RPM	100	200	300	580	720	870	1150	1750
Mech. HP	1.24	2.21	3.08	4.89	5.61	6.34	7.41	9.04
Thermal HP	1.24	2.21	3.08	4.20	4.62	5.10	6.00	7.80
Output Torque (inch-lbs.)	3340	3010	2830	2405	2250	2150	1940	1575

That's a lot of capacity for a unit that occupies less floor space than this magazine page. But it's typical of Cone-Drive speed reducers and gearsets. Complete details on this model in Bulletin 600-C. Other units to 800 HP and ratios to 4900:1.

CONE-DRIVE GEARS
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DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS
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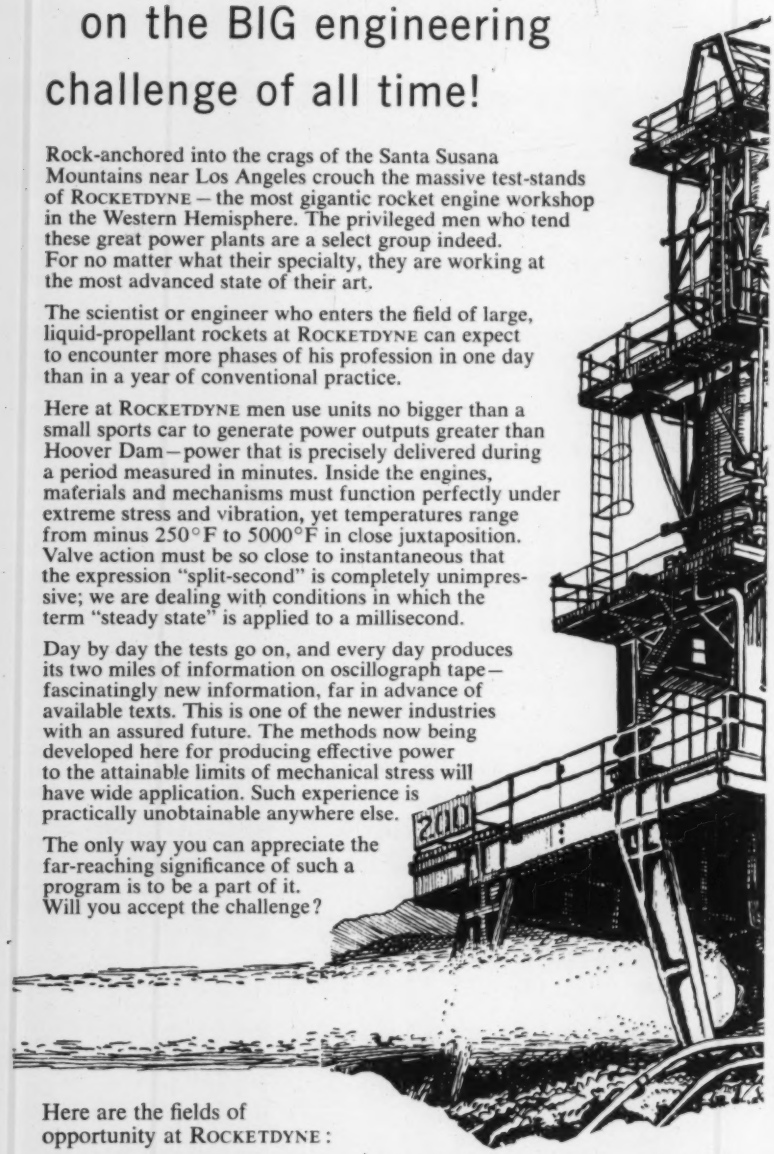
Here at ROCKETDYNE men use units no bigger than a small sports car to generate power outputs greater than Hoover Dam – power that is precisely delivered during a period measured in minutes. Inside the engines, materials and mechanisms must function perfectly under extreme stress and vibration, yet temperatures range from minus 250°F to 5000°F in close juxtaposition. Valve action must be so close to instantaneous that the expression "split-second" is completely unimpressive; we are dealing with conditions in which the term "steady state" is applied to a millisecond.

Day by day the tests go on, and every day produces its two miles of information on oscillograph tape – fascinatingly new information, far in advance of available texts. This is one of the newer industries with an assured future. The methods now being developed here for producing effective power to the attainable limits of mechanical stress will have wide application. Such experience is practically unobtainable anywhere else.

The only way you can appreciate the far-reaching significance of such a program is to be a part of it. Will you accept the challenge?



Here are the fields of opportunity at ROCKETDYNE:

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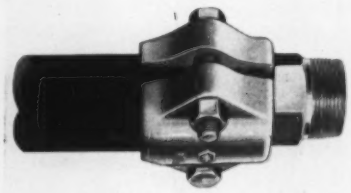
Bearing Mounting Plate

Pic Design Corp., 160 Atlantic Ave., Lynbrook, N. Y., announces that "AP" bearing mounting plates are immediately available from stock in shaft sizes of 1/8, 3/16 and 1/4, with clearance holes or tap holes to suit customer mounting requirements.

The firm says the plates eliminate the jig boring requirement to maintain tenth dimension on center to center distance allowing adjustable or floating center distances minimizing backlash. The adapter is made of cast aluminum and is finished in chromic acid anodized for protective purposes.



Clamp Hose End

Weatherhead Co., Fort Wayne Div., Fort Wayne, Ind., announces a new clamp-type hose end to provide maximum versatility in high-pressure lines for air, hydraulic fluids, steam. It couples readily on other types of hose, and meets practically any original equipment of field replacement hose-end need, the firm says. The end is made of malleable iron. Sizes are available in 1/4, 3/8, 1/2, 3/4, 1, 1 1/4, 1 1/2 and 2 in.

The unit is cadmium-plated to resist corrosion. Clamp halves, size for size, match perfectly, the firm states, and bolt holes assure constant center distances for true lineup of holes. Bolt-head hex-shaped recess eliminates need for two wrenches and the hose insert prevents restriction of hose ID.

Suggested fields of application include hydraulic machinery, air lines, steam lines.

Electronic Speed Drive

A new electronic variable speed drive available in capacities from 30 hp to 150 hp is announced by Raytheon Mfg. Co., Commercial Equipment Div., Waltham, Mass. The all-electronic unit consists of an operator's control station, electronic control unit and a d-c motor. The electronic control is comprised of an ignitron-controlled three phase, full-wave rectifier system with its associated firing circuits; variable field supply, tachometer feedback; protection and switchgear circuits. Dynamic braking, reversing, forward-reverse-jog operation, tachometer feedback, acceleration and armature current-limiting are included as standard features of the drive.

With the exception of the d-c motor, all components are static and have no inertial properties to slow down system response.

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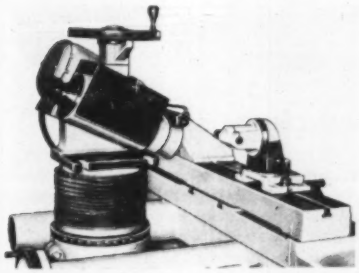
Industrially-proved ignitrons, thyratrons and magnetic amplifiers provide full-field starting, smooth acceleration, and infinitely variable speed over a wide range—at least 32:1—8:1 armature control, 4:1 field control—with a regulation of $1^1/_2$ per cent or better. Circuit features include complete fail-safe protection, automatic current limiting, armature voltage limiting, automatic ignitron current balancing and automatic compensation for line voltage fluctuations up to ±10 per cent.

The complete system is designed for dependability and ease of installation and maintenance. Modular design permits the use of many identical parts and assemblies in all sizes of the control. Its small size 5 ft × 5 ft × $2^1/_2$ ft up to 100 hp, and light weight saves valuable space and permits installation in otherwise impossible locations.

To meet future needs for increased automation, the speed drive is designed for inclusion in automatic systems. A small low-power d-c voltage is all that is required to control the motor speed. This control voltage is available as a function of the speed setting on the operator's control station; or one or more external voltages may be used which are derived from various transducers integrated in a machine or process.

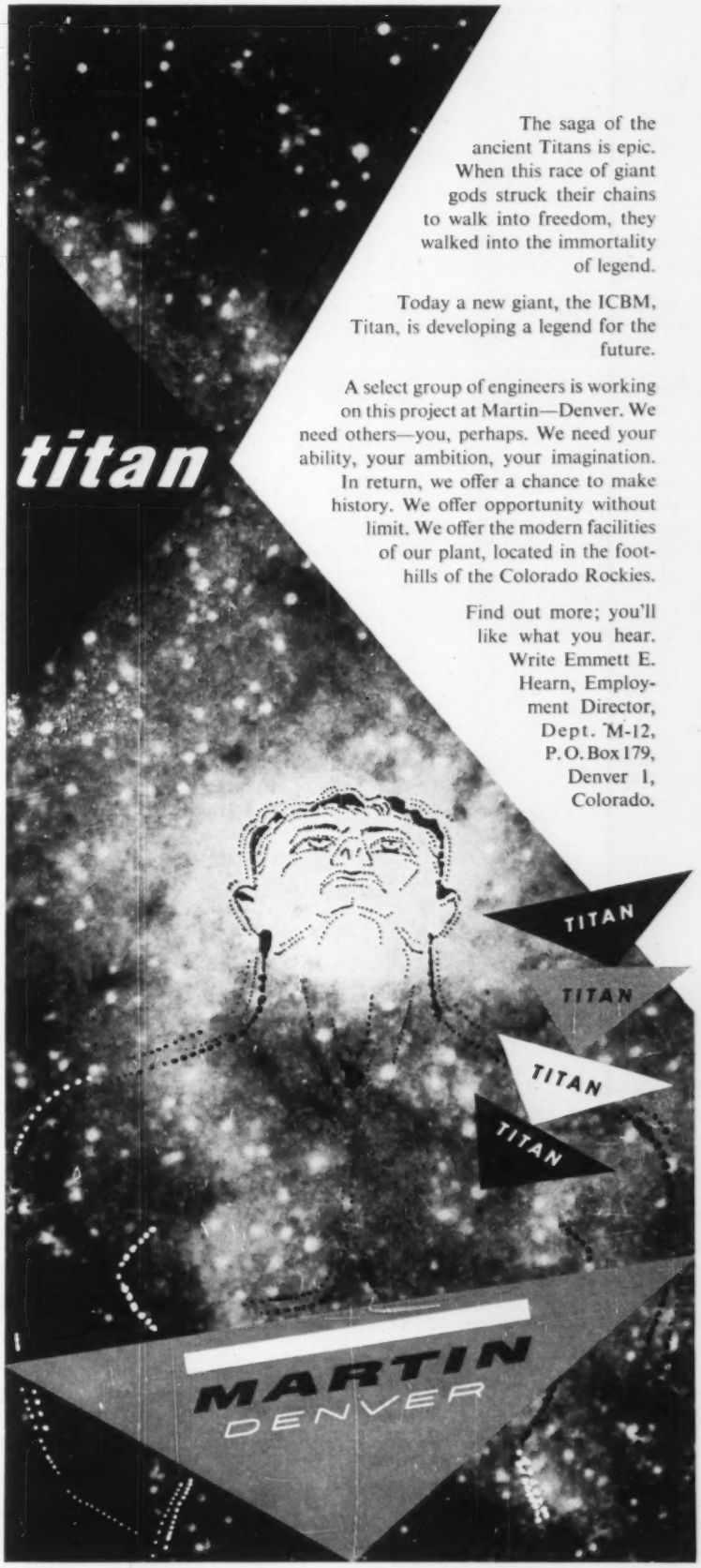


Tilting Spindle

Easier set-ups, fewer set-up changes and greater versatility are said to be major advantages of a new 25-deg tilting spindle on the Sterling G-2 tool and cutter grinder recently announced by McDonough Mfg. Co., Eau Claire, Wis.

Direct, positive setting of clearance angles without the use of formulas is claimed to speed set-ups and insure more accurate grinding. Because the clearance angle is set by tilting the spindle it is not necessary to change the setting for different diameters of work. A 3-deg clearance angle setting remains the same for a $^1/_2$-in. reamer and a 10-in. mill.

In addition to tilting, 25 deg at one end and 15 deg at the other, the new spindle is reversible and rotates a full 360 deg. Other features that add to the versatility and capacity of the machine are a $10^3/_4$ in. swing, improved massive anti-friction table with dual controls making operation easy from any position and ony other refinements.


titan
The saga of the ancient Titans is epic. When this race of giant gods struck their chains to walk into freedom, they walked into the immortality of legend.
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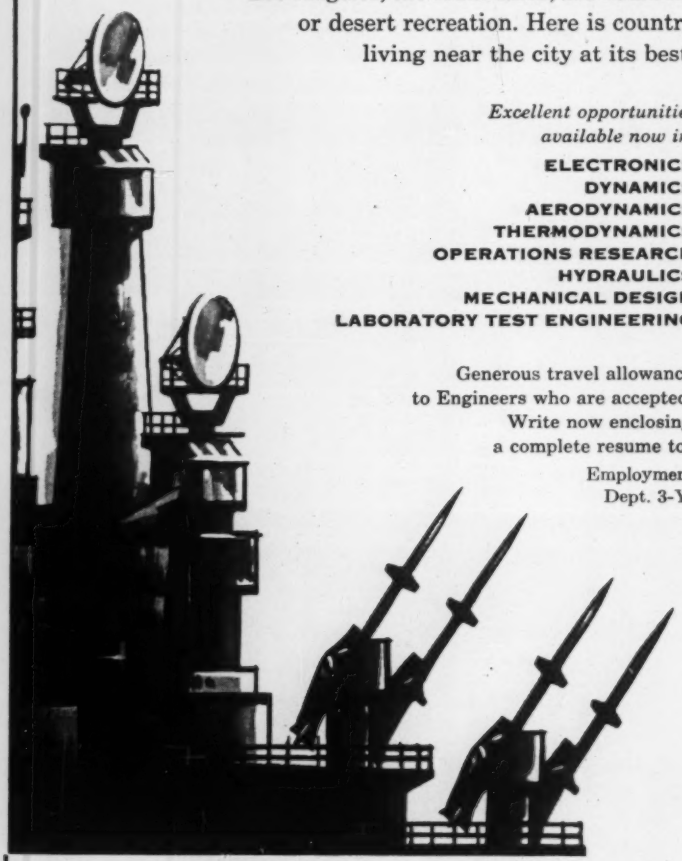

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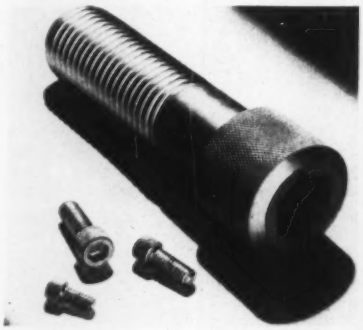
Welding Ignitron Salvage

A welding ignitron salvage program has been put into effect by the Westinghouse Electric Corp., Electronic Tube Div., Elmira, N. Y.

Each used ignitron tube of the following sizes: 5551, 5551A, 5552, 5552A, 5553, 5553B, will have salvage credit value, when accompanied by an order for a new tube of like size and for equal quantities. With the exception of rebuilt tubes, salvage credit will be given on any manufacturer's ignitrons. The following conditions would make used ignitrons unacceptable under the salvage program: dented cylinders; bent or broken water connections; hole burned through the cylinder; or damaged anode headers or cables.



Socket Screw Products

Cleveland Cap Screw Co., Cleveland, Ohio, has added the micro sizes, from No. 0 through No. 3, to its heat-treated alloy steel line of socket cap and set screws, completing a standard range of socket cap sizes up to 3 1/2 in. in diam and of socket sets up to 1 1/4 in.

In addition to cup points, cone, oval, half-dog and flat points are now available on the alloy steel set screws.

The firm is also marketing for the first time a line of socket head shoulder screws of heat-treated, alloy steel in standard diam sizes from 1/4 to 3/4 in., and heat-treated, alloy-steel, tight-seal pressure plugs in standard pipe sizes from 1/16 to 1 1/4 in. Another new product is precision-ground dowel pins in standard and oversize diameters from 1/8 through 1 in.

A line of stainless-steel socket cap screws and socket set screws have also been put on the market.

Socket cap and set screws in the new stainless line are made of 18-8 stainless steel, are nonheat-treated and nonmagnetic. The cap screws, with knurled head for sure grip, come in diameter sizes from No. 0 to 5/8 of an in. Fully formed threads are unified. Fit is 3A. Stainless set screws are available in sizes from No. 0 through 1/2 in. and come with cup point.

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Liquid Detergent

Development of a new concentrated liquid detergent, called Liqui-Det, has been announced by Oakite Products, Inc., 142A, Rector St., New York 6, N. Y.

The new detergent, which contains no soap, is said to go into solution instantly and to develop copious suds, in hard or soft water, hot or cold, and then to penetrate and loosen the most common soils in a very short time. Furthermore, the company states, it can be used repeatedly without rinsing, and without causing any build-up of film or discoloration. It is said to be safe on every type of surface and pleasant to the hands. Concentrations as low as 1/4 ounce to the gallon of water are being used with excellent results, the company states.

The firm says first field reports on the use of the detergent are being received from a variety of industries. A large brewery, for instance, is using it on red tile floors, a hospital on asphalt floors, a railroad on diesel cab interiors, a textile mill for removing rubber "burns" from fork-lift tires on concrete.

Metal Powder Spray

A new metal spray unit of improved design for applying hard-facing alloys and other metals in powder form is available from Wall Colmonoy Corp., 19345 John R. St., Detroit 3, Mich.

According to the company, the new unit features improved metal flow rates and increased deposit efficiency with no sacrifice in quality of the sprayed deposit.

Designated the Model C-2 Spraywelder. the unit is designed for use in applying hard-facing powders to most types of steel, including stainless, cast iron and copper parts by the Sprayweld process. In this process, the powdered alloys are first applied by spraying and then are fusion-bonded to the part by heating with an oxyacetylene flame.

Metal spraying operations using aluminum, zinc, copper, nickel, stainless steel, brass, lead, or high temperature brazing alloys in powder form can also be readily handled by the new unit, the firm states.

The unit's components are mounted on a crackle-finished panel that may be either wall or pedestal mounted. The complete unit includes a 3-lb aluminum pistol, a chromium-plated hopper, a carburetor, a combination air regulator-filter, and suitable oxygen, acetylene and powder hoses and fittings.

The companys says that foremost among the improvements provided in the new Spraywelder is a redesigned carburetor and new spraying head design which contribute to higher metal spraying capacity and greater deposit efficiency. New material specifications for many of the head and carburetor components are said to give longer life combined with improved performance.

Also featured is a new combination air regulator-filter which includes a clear-view plastic bowl that permits visual inspection for accumulation of moisture, dirt and oil.

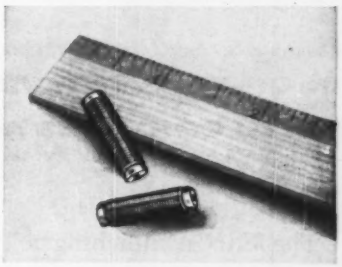
Production News from Bridgeport Thermostat

FROM THIS ALL-NEW PLANT—
MORE AND BETTER BELLOWS

On its new 15-acre site at Milford, Conn., Bridgeport Thermostat now has 180,000 square feet of automated production facilities to assure quick delivery of all the bellows or bellows assemblies you need . . . at the lowest possible cost. A temperature and humidity controlled room for charging bellows assemblies is only one of the many ways in which this ultra-modern plant promises you bellows assemblies of consistently high quality.

¼" DIAMETER BELLOWS

Progress at Bridgeport is typified by this tiny bellows for miniaturization. Available in seamless design with a wide range of characteristics in brass, phosphor bronze, beryllium copper and monel. Larger sizes available.



Robertshaw-Fulton
CONTROLS COMPANY

BRIDGEPORT THERMOSTAT DIVISION • MILFORD, CONN.

Please send me the following information: (Dept. XK-125)

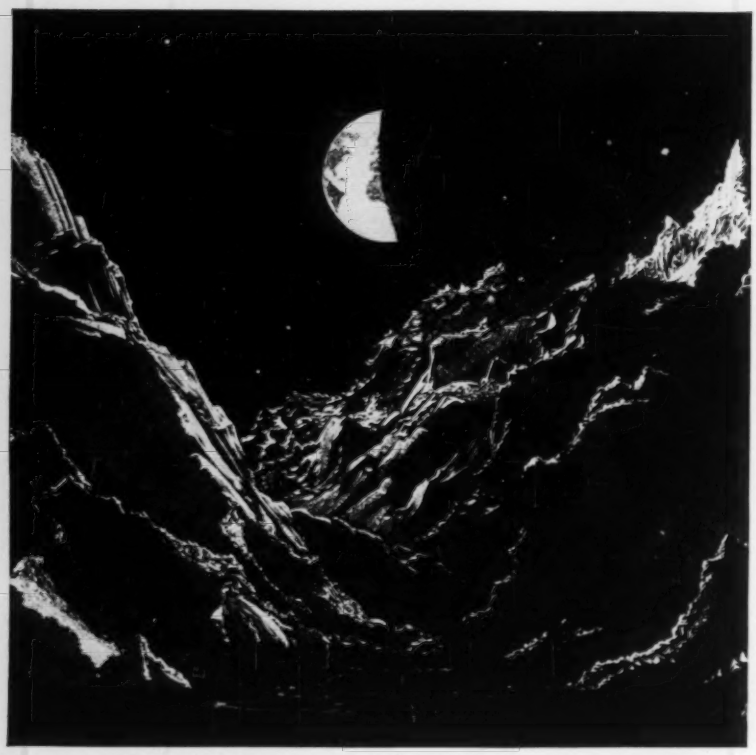
☐ Full details on small-diameter bellows.
☐ Bellows Engineering Bulletin.

NAME_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE_____ STATE_____



AN UP-TO-EARTH VIEW OF THE FUTURE IN SERVO CONTROLS AND INSTRUMENTATION

The Martin launching vehicle of the first man-made Earth satellite will be the opening gun of a new and endless age of exploration into space.

There are many exciting new opportunities at Martin in the fields of servo controls development and instrumentation engineering.

If you are doing some down-to-earth thinking on this fabulous future you'd do well to contact J. M. Hollyday, Dept. ME-12, The Glenn L. Martin Company, Baltimore 3, Maryland.

MARTIN
BALTIMORE

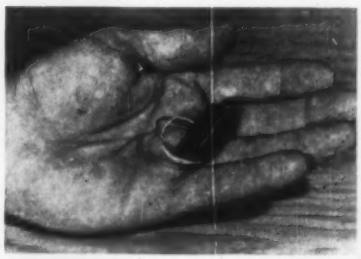
KEEP INFORMED — NEW EQUIPMENT BUSINESS NOTES LATEST CATALOGS

Motor Drives

Motor drives in a wide variety of speeds, suitable for servo work as well as for remote positioning applications, are now offered for the recently announced Type W2 and W5 Variac® Auto transformers by General Radio Co., 275 Massachusetts Ave., Cambridge, Mass. Ganged Variacs as well as single units can be supplied with motor drives in open or completely enclosed mountings.

Full-scale traverse rates of 4, 8, 16, 32, or 64 sec are available on all models, and a drive with a 2-sec traverse can be had on the Type W2, W2G2, or W5 Variacs. The 2-sec and 4-sec drives are intended for servo operations and use a motor with low moment of inertia and high angular acceleration. Medium-speed drives use this same motor with different gearing. Microswitch stops are always used on the 32- and 64-sec drives but are optional on the other models.

An extremely simple and straightforward mechanical design has been used in these drives. The gear reducer motor is attached to a mounting plate which in turn in ganged to the Variac. A gear coupling between the motor and Variac shaft is used to reduce alignment problems and to allow the use of one motor for a range of drive speeds. Ball bearings are used on all these motor-driven Variacs.



Subminiature Servo

Ford Instrument Co., Div. of Sperry Rand Corp., 31-10 Thomson Ave., Long Island City 1, N.Y., announces that the SM-58, a high precision, subminiature unit, has been added to its line of standard servo motors.

With nominal dimensions of only $\frac{5}{8}$ in. diam × 1 in. long (plus shaft extension), this tiny motor weighs under 1 oz. Its extreme small size, plus its valuable performance characteristics, make it applicable to servomechanisms, computers, indicating devices, missile control systems, aircraft control systems, and similar equipment, the firm states.

Featuring extremely high torque to inertia ratio, the SM-58 operates on 26 v 400 cy, with a control voltage range of 0–26 v. Typical characteristics include: $2\frac{1}{2}$ w input; $\frac{1}{10}$ w output; 0.063 in.-oz stall torque; 8800 rpm no load speed; 0.00038 oz-in.^{2} rotor inertia; and 64,000 rad per sec^2 theoretical acceleration at stall; ambient range is −75 to +200 F. The motor is available with smooth or splined shafts.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Optical Torque Tester

P. A. Sturtevant Co., Addison, Ill., announces what may be the first full range industrial production torque wrench tester.

This new precision tester features a torsional shaft measuring element that is submerged in pre-heated oil which enables constant operating temperatures for the measuring device. There is no mechanical connection between the measuring element and the indicating pointer, as the pointer is projected onto the scale through an optic system. The indicating pointer, as it appears on the television-type screen, travels across a ribbon scale for a distance in excess of 10 ft in total length.

The indicating pointer is a shadow image, and therefore there is no parallax error when an operator views the screen, the firm states. Correct readings can be made from either extreme side of the tester as well as from a perpendicular view.

Another feature of the tester is the fact that it is equipped with a power loading device. The manufacturer claims that the operator will no longer be confronted with the fatigue of hand loading torque wrenches or the process of loading with hand-operated mechanical devices. It is reported that a torque wrench can be tested to full capacity in just seconds, or it can be checked over each increment marking on the full scale range of the torque wrench rapidly and with extreme accuracy.

The loading arm is operated by an air-draulic system, and the movement of the loading arm can be controlled with a metering valve so that it will move as slowly as the hands on a clock or as rapidly as need be to load any type of torque wrench to full capacity almost instantly.

This tester has been designed not to meet the requirements of a single military service or industrial group, but rather for universal acceptance, and is said to be capable of testing all types of torque wrenches.

Combination Truck

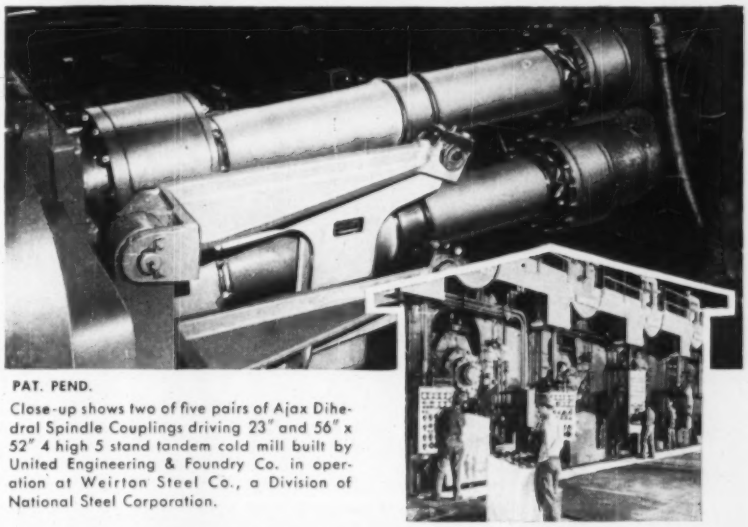
Yale & Towne Mfg. Co., 11,000 Roosevelt Blvd., Philadelphia 15, Pa., has announced the development of a heavy duty, dual purpose, rotating industrial lift truck attachment which will permit the truck to double as a standard fork truck and a textile or paper bale handler.

The firm says versatility of the attachment permits the handling of two dissimilar loads with the same truck. It will prove particularly beneficial, the company states, in paper processing plants where certain raw materials are received and handled on pallets while waste paper bales must be clamped for removal from the plant, neither duty having sufficient frequency to keep two trucks constantly in use.

The attachment uses two sets of hydraulically controlled, 8-in. wide forks mounting on opposite sides of the fork carriage for clamp-

AJAX

DIHEDRAL SPINDLE DRIVE COUPLINGS HANDLE SPEEDS UP TO 7200 FPM



PAT. PEND.

Close-up shows two of five pairs of Ajax Dihedral Spindle Couplings driving 23" and 56" x 52" 4 high 5 stand tandem cold mill built by United Engineering & Foundry Co. in operation at Weirton Steel Co., a Division of National Steel Corporation.

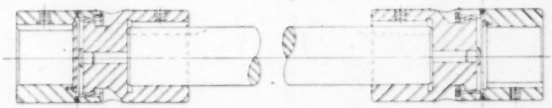
● One of America's newest and most talked about mills is driven by ten Ajax Dihedral Spindle Couplings.

This 23" and 56" x 52" 4 high, 5 stand tandem cold mill is turning out sheet of high quality finish and maintaining close gauge tolerance at speeds up to 7200 fpm.

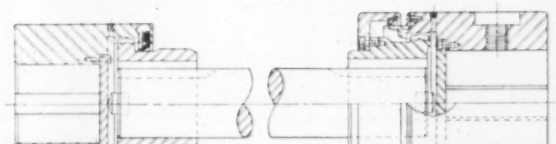
Uniform angular velocity made possible by Ajax Dihedral Spindle Couplings is an important factor in the performance of this high speed mill built by United Engineering & Foundry Co. for Weirton Steel Co., a Division of National Steel Corporation.

Each of these couplings delivers 2500 hp between drive stand and rolls.

The proven performance of Ajax Dihedral Spindle Couplings is writing new standards into the specifications of mill builders and new figures into the production and maintenance cost records of mill users.



Sketch shows 9" diameter by 5'6" overall length Ajax Dihedral Spindle Coupling. Arranged for booted lubricant retainer seal.



Showing Ajax Dihedral Spindle Coupling 6'4½" overall with 15¼" diameter coupling on roll end and 13¾" diameter coupling on drive end.

AJAX FLEXIBLE COUPLING CO. INC.
WESTFIELD, N. Y.

Can you qualify for one of these six specialized engineering positions?

1 **Experienced Instrument Engineer.** Design work on aircraft instruments, controls and displays. Electrical Engineering degree or equivalent essential. Human Factors engineering experience on displays desired.

2 **Experienced Human Factors Engineer.** Design work on aircraft control and displays. Industrial Psychology degree or equivalent essential. Specific experience on instruments desired.

3 **Experienced Aircraft Air Conditioning Engineer.** Work on weapons system advanced design aircraft. BSME or equivalent essential.

4 **Experienced Aircraft Engineer.** Work on environment control engineering or weapons system advanced design aircraft. BSME or equivalent essential.

5 **Experienced Aircraft Engineer.** Work on escape systems design on weapons system advanced design aircraft. BSME or BSAE degree or equivalent essential.

6 **Experienced Aircraft Engineer.** Cockpit arrangement and provision studies on weapons system advanced design aircraft. BSME or equivalent essential. Human Factors experience desirable.

CONTACT: Mr. Les Stevenson, Engineering Personnel Office.
Dept. 56 ME, North American Aviation, Inc.
Los Angeles 45, California.

Los Angeles Division

NORTH AMERICAN AVIATION, INC.

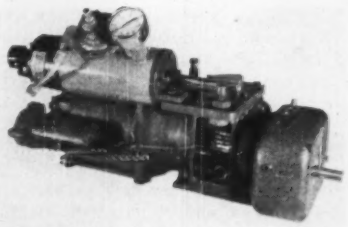
North American Has Built More Airplanes Than Any Other Company In The World

KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

ing surfaces. Used as a clamp, it can securely pick up, lift and carry bales varying from 27 to 75 in. in width. The 360-deg rotating characteristic of the fork carriage permits either horizontal or vertical placement of the load.

With the upper set of clamping arms extended out of the way the attachment can be used to handle pallet loads up to 75 in. in height. Either set of forks can be used to carry pallets merely by 180 deg rotation of the attachment.

On a 5000-lb capacity truck, the new fork-clamp can handle loads up to 3200 lb at a 24 in. load center, the company says.



Automatic Speed Control

A new air control system for high accuracy fractional horsepower variable speed drives is announced by Graham Transmissions Inc. This new control for the firm's 29 series transmissions can be used on drives delivering speeds from any desired maximum down to zero and, if desired, reverse.

High accuracy setting and maintenance of speed over the entire range is featured. Linear speed vs. pressure characteristic is standard with most models but square root function and other characteristics are possible.

A 1/4 hp unit with pneumatic operator and with built-in helical spur reducer and built-in single phase, explosionproof motor is shown in the photograph. The pneumatic control operates on a 3 to 15 psi signal with control signal originating from liquid level, pressure or flow rate devices or a variety of other transducers. The control signal may also be transmitted from any one of the leading makes of pneumatic recorders or recorder controllers. Normally zero speed is obtained at a control pressure of 3 psi with maximum speed at 15 psi. However, the control can be installed to produce zero or any other speed at 15 psi.

The transmission is available with a variety of built-in reducers including spur and worm reduction types with output shaft horizontal or vertical. Built-in motors of all types can be furnished or the drive may be coupled or belt connected to the driving means. Larger units—up to 3 hp—are also available with similar air controls. The assembly of motor, variable speed drive, reducer and pneumatic control are mounted with only four bolts.

Continued on Page 69

Need more engineering information on products advertised in this issue?

USE THE POSTAGE-FREE CARDS . . .

If you would like further engineering information on any of the products advertised in this issue, circle the page numbers of these ads on one of the cards below . . . fill in your name and address and mail to us. Your requests will be forwarded to the advertiser. The information will come directly to you.

(Note: This service does not apply to students.)

MAIL THIS CARD ▶

after circling the page numbers and filling in your complete address.
NO POSTAGE REQUIRED

When more than one advertisement appears on a page, the following code identifies the location of the ad on page: T-top, B-bottom, L-left, R-right, IFC-inside front cover, IBC-inside back cover, OBC-outside back cover.

FIRST CLASS
PERMIT No. 1144
NEW YORK, N. Y.

BUSINESS REPLY CARD
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

3c POSTAGE WILL BE PAID BY

MECHANICAL ENGINEERING
29 West 39th Street
New York 18, N.Y.

MECHANICAL ENGINEERING—DECEMBER 1956 issue

IFC	16	29	43	57	75	85	102	120	133	165
1	17–18	30	44T	58L	77L	87	103	121	134	IBC
2	19	31	45	59	77R	89	105	123	135	OBC
3	20	32	47	63	78	90	107	124	136T	
4–5	21	33	48T	65	79T	91	109	125	137TR	
6–7	22	34	48B	69	80L	93	111	126	137B	
8–9	23	35	49	70B	81L	94	113	127	138L	
10–11	24–25	37	52L	71	81R	95	115	129	138R	
12–13	26	39	53	72TL	82L	97	117	130	139	
14	27	40	54	72TR	82R	99	118	131	140	
15	28	42	55	74L	83	101	119	132	163	

PLEASE SEND me more complete engineering information on the products advertised in the pages circled above.

NAME.....

TITLE.....

COMPANY.....

ADDRESS.....

CITY and STATE.....

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3	20	32	47	63	78	90	107	124	136T	
4–5	21	33	48T	65	79T	91	109	125	137TR	
6–7	22	34	48B	69	80L	93	111	126	137B	
8–9	23	35	49	70B	81L	94	113	127	138L	
10–11	24–25	37	52L	71	81R	95	115	129	138R	
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NO POSTAGE REQUIRED

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Abrasive Blast Cleaner

A new size of Super Tumblast airless abrasive blast cleaning machine for cleaning sand, scale, oxides, and other contaminants from metals has been introduced by Wheelabrator Corp., Mishawaka, Ind.

This batch-type machine is for work that can withstand a tumbling action. It has an operating load capacity of 14 cu ft.

BUSINESS NOTES

Tulsa, Milwaukee Agents

A. W. Cash Co., Decatur, Ill., and its subsidiary, Cash Standard Stacon Corp., have announced the appointment of two new sales agents for pressure, temperature, hydraulic, process and combustion control equipment.

Representing Cash in the Tulsa territory is Arduser and Co., PO Box 4267, Tulsa 9, Okla. In the Milwaukee territory the new agent is T. R. Christy Co., 3253 North Green Bay Ave., Milwaukee 12, Wis.

Western Field Office

A new western field service office was opened at 10816 Washington Blvd., Culver City, Calif., by MB Mfg. Co., a division of Textron, Inc., New Haven, Conn., producer of precision vibration test equipment for aircraft, electronics, and other major western industries.

Planned jointly by MB and Pacific Scientific Co., the technical staff at the new office includes specialists for installation checkout and service and for training of customer personnel in operating vibration test systems. The facilities of the office and its stock of replacement parts will service all of California, Nevada, Arizona, Washington, and Oregon.

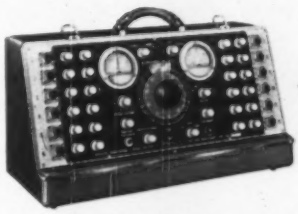
Los Angeles Plant

Establishment of engineering and manufacturing facilities in Los Angeles is announced by Clark Controller Co., manufacturers of industrial electrical control equipment.

The company has occupied a 10,000 sq ft building in the Vernon Central manufacturing district for its newly-established Los Angeles Division, which will include the former Los Angeles district sales office as well as the new engineering and manufacturing departments.

The company's sales offices and local stocks of standard controls and control parts will be moved to the new building, located at 4755 E. 49th St., Los Angeles 58. Manufacturing operations, which at first will consist primarily of engineering and assembly of special control panels and motor control centers were scheduled to begin about Sept. 1.

Measure strain *directly*, in the lab or in the field...



The Hathaway RS-20

NOW you can speedily measure static strain accurately and *directly* off one dial in microinches per inch. Save hours of tedious calculations by using this versatile, *portable* strain indicator.

MULTI-CHANNEL CHOICE—The RS-20 is available in 2, 6 or 12 channels.

THREE RANGES PROVIDED—0-1000, 0-10,000 and 10,000-20,000 microinches per inch.

ACCURATE—Accuracy of ±2 microinches per inch is obtained within the 0-1000 range.

ADVANCED CIRCUIT DESIGN—Stable circuitry employs ten-turn resistance and capacitance balancing controls.

WA STRAIN GAGE LEADS are the perfect working tools for the RS-20 and are available in any length up to 500 ft.

Discover how you can speed measurement of strain. Ask for a Hathaway representative to call and give you more information or write for Bulletins 3-2G and 4-5G.

HATHAWAY INSTRUMENT DIVISION
HAMILTON WATCH COMPANY

1315 SOUTH CLARKSON STREET • DENVER 10, COLORADO

• NEW YORK 600 Fifth Ave. Plaza 7-7947 • CHICAGO 35 E. Wacker Dr. State 2-6411 • DENVER 1315 S. Clarkson St. Spruce 7-2696 • DETROIT 1960 E. Lincoln Ave. Birmingham, Mich. Midwest 4-9004 • PASADENA 380 E. Green St. Ryan 1-7829 • ALBUQUERQUE 2221 Silver Ave., S.E. 5-9632

devoted to Research

GYRO ASSEMBLY AND TEST

Mechanical and Electrical Engineers, with a personal interest in precision mechanisms, where a high degree of accuracy is required, and a pride in the precision of the product they help build, we offer truly challenging opportunities.

You will do development work and testing in one of the country's most versatile laboratories, working with the top men in the field and the finest test, research and development equipment. As a part of our Major, Permanent, Expansion Program, new plant facilities are being added in suburban Milwaukee.

AC provides financial assistance toward your Master's Degree. Graduate program also available evenings at Univ. Wisconsin, Milwaukee. GM's aggressive position in the field of manufacture and GM's policy of decentralization creates individual opportunity and recognition for each Engineer hired.

RECENT EE, ME GRADUATE INQUIRIES ALSO INVITED

Milwaukee offers ideal family living in a progressive neighborly community in Southern Wisconsin.

To arrange personal, confidential interview in your locality send full facts about yourself to

Mr. John F. Heffinger, Supervisor of Salaried Personnel

THE ELECTRONICS DIVISION

GENERAL MOTORS Corporation

FLINT 2, MICH. **MILWAUKEE 2, WIS.**

This rugged new engine has been added to the Wisconsin line to fill the horsepower gap between the Model VF4 25 hp. and the Model VG4D 36 hp. Wisconsin Engines. At the same time, the mounting base is dimensionally identical to the Models VE4 and VF4 to permit convenient replacement of the latter engines if greater power is required.

The Model VH4, which now makes its bow for the first time, is the most powerful engine of its type and size available today, in our estimation. It is an engine of basic High Torque design which gives it the important advantage of being able to deliver maximum usable *Lugging Power* that carries the load through the hard, heavy pulls. It has been designed to give you the best possible performance at all engine speeds from 1400 to 2800 rpm., even when operating under intermittent shock-loads or under constant load, continuous service. It is an exceptionally smooth-running, even-firing engine and has all the traditional heavy-duty features that characterize *all* Wisconsin Models, from 3 to 36 hp. — built for hard service at all temperatures up to 140° F.

Learn more about this new engine. Write for Bulletin S-196 for detailed data and engineering specifications. Also ask for Service Map Bulletin, Form S-198.

WISCONSIN MOTOR CORPORATION

World's Largest Builders of Heavy-Duty Air-Cooled Engines

MILWAUKEE 46, WISCONSIN

KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

Adds Finishing Facilities

Arwood Precision Casting Corp., New York, N. Y., has extended its production facilities to include finish-machining of both ferrous and nonferrous castings to customer specifications.

All Arwood plants at Brooklyn, N. Y., Groton, Conn., Tilton, N. H., and Los Angeles, Calif., have been enlarged and are now fully equipped to accept orders for finish-machined castings, it is announced by the company. Price and delivery quotations will hereafter be made on both unfinished castings and finish-machined parts.

Tri-State Representative

Koppers Company, Inc., Pittsburgh 19, Pa., has announced that Longenecker Associates of Pittsburgh has been named representative for two major products of the company's Metal Products Div.

The firm will represent Koppers in the sale and promotion of Aeroturn dust filters and Koppers mechanical dust collectors in eastern Ohio, northern West Virginia, and western Pennsylvania.

Research Unit Formed

Lord Mfg. Co. 1635 W. 12th St., Erie, Pa., announces the establishment of a Special Products Division to continue the intensive research and development program started by the parent company in the field of adhesives, chemicals and other polymers.

As a part of its long range program, a research grant at the Massachusetts Institute of Technology for study on the "Fundamentals of Adhesion" has been in effect for several years. The new division is presently manufacturing several new adhesives for the bonding of uncured elastomers to metal. These adhesives are being marketed by the new division under the trade name "Chemlok."

Separate research and manufacturing facilities have been established at the parent company location.

Division Sold

Market Forge Co., Everett, Mass., announces the sale of its Materials Handling Div., to American Pulley Co., Philadelphia, Pa., effective November 1, 1956.

This move was made necessary by the rapid growth of the Market Forge Co., over the past several years and the need to devote its full plant and facilities to its other divisions. Over the past 60 years the company has become an important factor in the fields of commercial food service equipment, commercial refrigerator equipment, hospital equipment and automative accessories.

American Pulley is also a major factor in the power-transmission equipment field. It will manufacture its newly acquired Market Forge materials-handling line in its recently expanded plant in Philadelphia.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Piping Division Sold

Lummus Co., 385 Madison Ave., New York 17, N. Y., announces the sale of its Fabricated Piping Div., 504 W. 145th St., East Chicago, Ind., including land, buildings, equipment and the business of this division to Messrs. R. A. Steele and J. J. Friedman of New York City effective August 1, 1956 with final closing of the sale on September 24, 1956.

The new company is known as the Pipe Fabricators, Inc., with general office and plant located at 504 W. 145 St., East Chicago, Ind.

LATEST CATALOGS

Pressure Greases

Two water-resistant extreme pressure greases especially recommended for shock-loaded bearings are described in Technical Bulletin 49, available from Sun Oil Co., Philadelphia 3, Pa.

Grinding Wheels

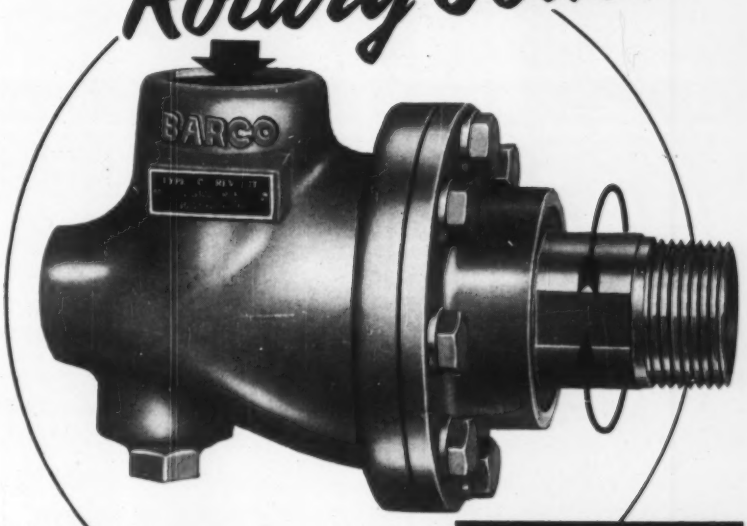
An illustrated bulletin on grinding wheel specifications and marking data has been prepared by Electro Refractories & Abrasives Corp., 344 Delaware Ave., Buffalo 2, N.Y. The booklet points out that resin wheels are most commonly associated with "snagging" operations in steel mills, foundries and metal fabricating plants where heavy, rapid metal removal is the prime consideration. These wheels, recommended for higher operating speeds than vitrified, are noted for high strength, resilience and resistance to thermal shock. Vitrified wheels have either glass or porcelain bonds regarded as best for precision grinding. They are generally limited to a maximum speed of 6500 surface ft and their rigidity permits very accurate grinding.

Brazing Alloys

Descriptive literature is available on the series of high-temperature brazing alloys recently introduced for brazing stainless steel and a variety of heat-resistant alloys by Handy & Harman, 82 Fulton St., New York 38, N. Y.

The brochure gives specifications, selection factors, recommended applications, and other pertinent data on the four Hi-Temp alloys, which are basically nickel alloys having nickel contents ranging from 72.5 to 93.25 per cent. Since these alloys form a bond by alloying with the parent metals, the strength of the joint will be equal to or better than the strength of the metal itself. The literature also describes a six-step procedure for obtaining high quality joints with these brazing alloys.

NOW-A Better Rotary Joint!



SIZES
½" ¾" 1" 1¼"
1½" 2" 2½" 3"

NEW BARCO TYPE C Rotary Joint

Announcing...

It's new! It's simple! It's versatile! And for countless applications, Barco's new Type C Rotary Joint will give you the best operating records you've ever had.

FOR ALL SERVICES—One basic style of revolving joint for single flow or syphon flow ... one basic seal for steam, air, water, oil, gas — *or alternating hot and cold!* For temperatures to 450°F. Special to 500°F.

NO LUBRICATION NEEDED — Bearings and seal self-lubricating. Seal self-adjusting for wear. Long life without repairs or maintenance.

LOW TORQUE — Low starting and running torque*. Saves power. Suitable for any ordinary speed. To 200 psi, steam, or 400 psi, hydraulic.

COMPACT, SIMPLE — Malleable iron body; heat treated steel shaft; R.H. or L.H. thread. Eight sizes, ½" to 3".

**Typical example: 12 in. lbs. starting torque for 1" Type C on 100 psi water. Rotating torque, same.*

for
STEAM
WATER
OIL
AIR or GAS

SEND FOR NEW CATALOG 310 TODAY.

FOUNDED 1908
BARCO
PRODUCTS BACKED BY EXPERIENCE

BARCO MANUFACTURING CO.
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The Only Truly Complete Line of Flexible Ball, Swivel, Swing and Revolving Joints
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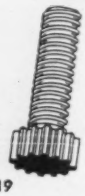

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KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

Calculating Board

A two-page bulletin describing the company's new Seidel calculating board for evaluating photometric data from spectrographic films and plates is available from Jarrell-Ash Co., 26 Farwell St., Newtonville 60, Mass.

Through use of the Seidel transformation principle, the calculating board eliminates much of the labor involved in constructing spectrographic emulsion calibration curves, and transforms the usually encountered logarithmic curves into easily interpreted, nearly straight lines, it is stated. Among the features incorporated into the unit is a separate sliding scale which permits background corrections to be made directly.

Hydrolubes Booklet

A 16-page booklet, "Ucon Hydrolubes Spell Safety," has been issued by Carbide and Carbon Chemicals Co., Div. of Union Carbide and Carbon Corp., 30 E. 42nd St., New York 17, N. Y.

This booklet describes new CP hydrolubes and gives physical properties. It discusses the advantages and limitations of water-base fire-resistant hydraulic fluids and contains complete information on the installation, use and maintenance of the hydrolubes. The new CP hydrolubes are said to have outstanding corrosion and wear resistance, and are used in applications where petroleum oils would present a fire hazard.

Casting Design

A 64-page manual published by the Meehanite Metal Corp., 714 North Ave., New Rochelle, N. Y., covers the form of design, the method of making the pattern, molding procedure, the characteristics and behavior of the metal in the mold and other elements involved in the production of sound, dependable engineering castings.

Vacuum Pumps, Boosters

Bulletin 5H3, published by Schutte and Koerting Co., Cornwells Heights, Pa., describes the company's three-, four-, and five-stage steam jet vacuum pumps and vacuum boosters.

The pumps are used where single- and two-stage units will not provide economically suction pressures as low as desired. Suction pressures provided by the units described in the bulletin are three-stage units, 15 mm Hg. abs. to 1 mm Hg. abs.; four-stage, 2.25 mm Hg. abs. to 0.2 mm Hg. abs.; five-stage, 0.25 Hg. abs. to 25 microns Hg. abs.; vacuum boosters, 25 mm Hg. abs. to 5 mm Hg. abs.

For Consulting Engineers Turn to Page 162

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Cooling Towers

Twenty-four sizes of quiet-operating cooling towers for business and industry are described in a 12-page bulletin, 477-A, offered by the Binks Mfg. Co., 3122 Carroll Ave., Chicago 12, Ill.

The illustrated booklet explains that the "whisper-quiet performance" of the fans is due to tip speeds under 2300 fpm. Squirrel cage blower, motor and drives are located in the dry air stream. No moisture laden air penetrates this vital mechanical equipment in the cooling tower, it is stated. Dimensions and approximate weights are given for each of the 24 cooling towers which range from 5 to 360 tons of refrigeration. Selection tables for a wide range of design wet bulb conditions are also included.

Brazed Assemblies

A four-page illustrated two-color catalog describing the facilities and services provided by the company's Wallco Mfg. Div. is available from Wall Colmonoy Corp., 19345 John R St., Detroit 3, Mich.

The new catalog discusses facilities for design, development and manufacture of copper and silver brazed assemblies. It is illustrated with photos of the facilities and of typical examples of the workmanship performed by the division. Brazed tube assemblies, brazed levers and linkages, brazed assemblies of stamped components and brazed hydraulic and vacuum fitting designs are among the parts shown.

Optical Tooling

A 20-page illustrated booklet explaining the theory, principles, and practice of optical tooling for measuring, positioning, and aligning is available from Charles Bruning Co., Inc., 4700 Montrose Ave., Chicago 41, Ill.

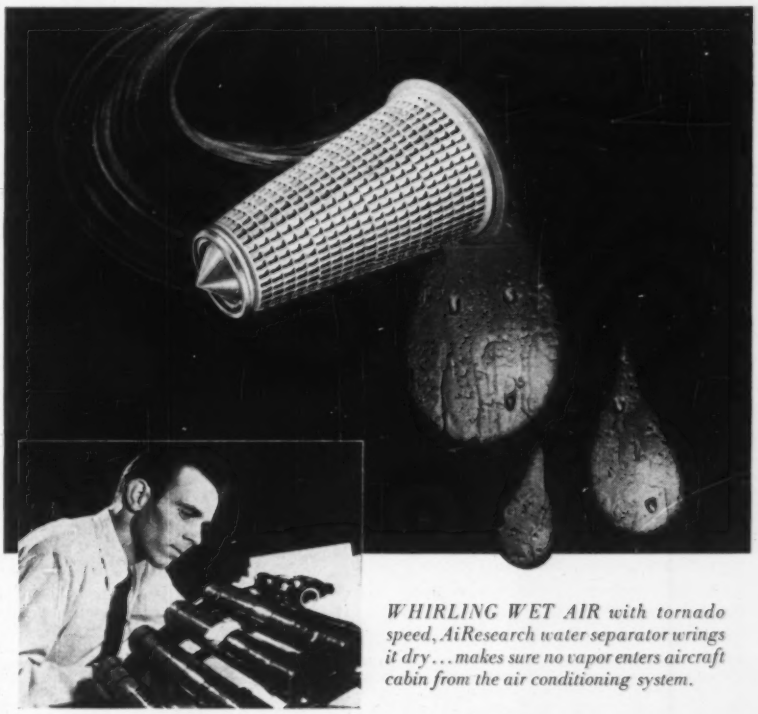
In addition to explaining the basic theory of optical tooling and showing some of its applications, the booklet also illustrates and describes the firm's line of optical tooling instruments and accessories.

Aircraft Switches

Micro Switch of Freeport, Ill. a division of Minneapolis-Honeywell Regulator Co., has published a 24-page catalog on aircraft switches, Catalog 77, covering 12 different families of precision, snap-action aircraft switches. In all, over seventy different enclosed switches are described.

Complete with photographs, dimensioned drawings, electrical ratings, and technical information the catalog includes environment-proof switches, hermetically sealed switches, completely sealed cylindrical switches, high temperature switches, enclosed multi-circuit switches and switches which are JAN, AN and/or MS approved. Many of the switches covered are available in a variety of actuator designs and contact arrangements.

To the engineer with a bent for research...



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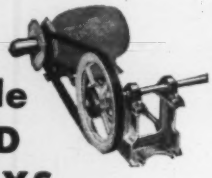

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KEEP INFORMED — NEW EQUIPMENT BUSINESS NOTES LATEST CATALOGS

Feed Units

A bulletin covering the philosophy of "Storage-in-Motion"—for parts that roll, such as gears, screw machine parts, etc.—is now available from the Gear-O-Mation Div., Michigan Tool Co., 17140 E. 10 Mile Rd., East Detroit, Mich. The four-page two-color bulletin (No. GO-561) describes the equipment—storage units, collectors, distributors—as developed by Michigan Tool's newest division. These units make up to a complete demand feeding system for in-line machine operations. Using gravity flow, zig-zag track and elevators, and enclosed storage, the method offers a positive control of parts flow between successive operations and allows for over-all maximum efficiency.

Tube-Working Tools

Tube Fabricating Equipment Catalog No. 1140, just issued, covers Parker hand tools—tube cutters, flarers, benders—also bench-mounted benders, power flarer, straight thread tapping and counter-boring tools, etc. The 24-page book includes a section on how to use the tools. Available from your Parker distributor or from W. D. Wynant, Tube & Hose Fittings Div., Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.

Large Nuts

A bulletin on a new line of large nuts has been issued by the Security Locknut Corp. Melrose Park, Ill.

Included are large, standard nuts, jam nuts and slotted nuts, as well as locknuts. Large nuts can be furnished from stock in standard and special hexigon dimensions. Standard nuts can be furnished semi-finished, tapped, Class 2 or better. Bearing surface is washer faced at right angles to thread.

Swivel Joints

A 12-page catalog, No. 269-A, on an expanded line of aircraft type swivel joints has been published by Barco Mfg. Co., Dept. J28 500 N. Hough St., Barrington, Ill.

Offered are two new designs conforming to Mil-J-5513A and other specifications. The catalog explains in detail the low torque plane swivel type which provides 360 deg rotation in a single fixed plane, and the self-aligning type which provides 360 deg rotation plus 15 deg side flexibility. Illustrations of all standard patterns are shown with specifications for flared and flareless end connections in aluminum, steel and stainless steel for pressures up to 4000 psi.

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Because of its predominantly professional character, APL has kept in the vanguard, having pioneered the proximity fuze, the first supersonic ramjet engine, the Navy's Bumblebee family of missiles which includes the TERRIER, TALOS and TARTAR; and is presently attempting break-throughs on several important fronts.

Occupying a site equidistant from Washington, D. C., and Baltimore, Maryland, APL's new laboratories allow staff members to select urban, suburban or rural living, and either of these outstanding centers of culture as a focal point for fine living. Salaries compare favorably with those of other R & D organizations.

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8607 Georgia Avenue, Silver Spring, Md.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Atomic Power Plant

Competitive power from the atom and the capabilities of the company to supply reactor power plants are covered in a bulletin offered by Alco Products, Inc., Box 1065, Schenectady, N. Y.

The publication features a five-page transvision of a pressurized-water reactor core designed and built by the firm for the Army package power reactor for the Atomic Energy Commission and the Army Corps of Engineers. The 12-page bulletin describes the company's work in the field of atomic power, depicts photographically the APPR and the company's new criticality facility at Schenectady, and contains a line-drawing of the pressurized-water reactor cycle. It also contains a heat balance diagram of a typical nuclear power design with an accompanying characteristics chart.

Grinding Mills

Hardinge Co., Inc., 240 Arch St., York, Pa. has issued a six-page brochure, AH-474, covering its major types of reduction mills for both wet and dry grinding and pulverizing.

Briefly described are Tricone, rod, cylindrical, tube, batch, conical and disk roll mills. Materials which have been dry or wet-ground in these mills are listed. There is also a brief description of grinding mill accessories and classifying devices.

Transi-Twins Pneumatic & Electric Transmitters

Bulletin No. 170 describing unusual design features of new pneumatic and electric transmitters for rotameters is available from Brooks Rotameter Co., Lansdale, Pa. The transmitters can be used with secondary instruments of any manufacture, the company states.

The bulletin contains detailed application and operational data supplemented by schematic drawings.

Industrial Fluid Drives

A 16-page illustrated two-color catalog, Bulletin 9119, covering Gyrol fluid drives for $\frac{1}{2}$ to 25 hp applications is available from American Blower Corp., Detroit 32, Mich. The bulletin describes the company's Type T, Type TM and Type VS Class 2 units for industrial use in the low horsepower range.

The fluid drive principle is explained and advantages of the units are outlined. Typical performance curves compare starting torque, starting current and heat generation characteristics of a general purpose a-c motor direct-connected to a load with those of a similar motor utilizing fluid drive. Other charts show typical adjustable speed torque curves with NEMA Design B motor for various degrees of filling and the effect of load ring size on torque/speed characteristics.

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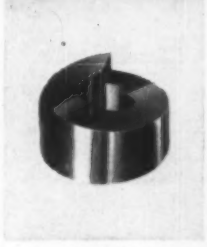

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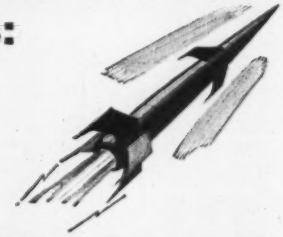

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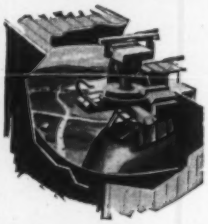

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KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

Annunciator Systems

Available from the Panalarm Division of Panellit, Inc., 7401 N. Hamlin Ave., Skokie, Ill., is a 32-page catalog, No. 100B, describing the complete line of standard, integrated Panalarm annunciator systems for industry.

The new catalog organizes, in fourteen sections, the complete story of the Annunciator System. The first three sections discuss company facilities, annunciator function and general features of the systems. Section four illustrates typical industry applications. The following six sections present operating sequences, enclosures, mechanical specifications, technical data and performance features of specific types of annunciator systems. Available remote equipment and components, ordering information and engineering data are included in the remaining sections.

Forged Steel Unions

A new eight-page bulletin, U-1-56, announced by W-S Fittings Div., H. K. Porter Co., Inc., P.O. Box 95, Roselle, N.J., presents complete dimensional and engineering data on the complete line of W-S forged steel unions for high pressure service.

Types of unions described in the new bulletin are: 3000 lb forged steel unions, designed to AAR dimensional specifications; 2-bolt and 4-bolt flange unions in 2000 lb and 3000 lb classes; 3000 lb O-Ring flange unions; orifice unions; tab orifice unions; the W-S clamp ring unions; forged stainless steel unions; forged steel unions with bronze-to-steel and stainless-to-steel seats; and lug nut unions.

Shaded-Pole Motors

General Electric Co., Schenectady 5, N. Y., has issued GEA-6134A, a 12-page publication describing shaded-pole motors for fan and blower applications in ratings 1.5 w through $^1/_4$ hp.

The two-color bulletin contains application, rating, and dimension data on $5^1/_2$-in. (39-frame) motor rated $^1/_{12}$ through $^1/_4$ hp; 5-in. (21-frame) motor rated 25 mhp through $^1/_{12}$ hp; 4-in. (11-frame) motor rated 15 mhp through 35 mhp; and $3^1/_2$-in. (51-frame) motor rated 1.5 through 16 w.

PAST EXAMINATIONS

for Professional Engineers given by New York State

This pamphlet contains the questions given in 1952–1956 examinations. They cover problems in structural planning and design, in practical applications of basic engineering sciences, and the more advanced and specialized problems in practical applications of engineering principles and methods.

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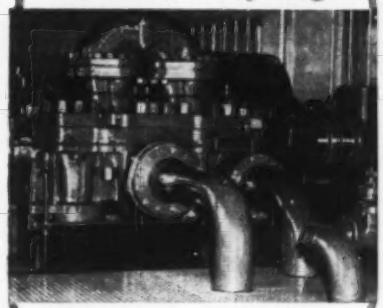
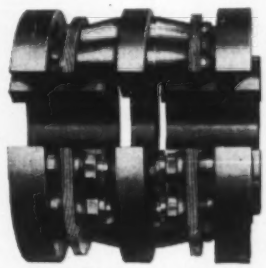


One Chemical Engineer reports he formerly spent 95% of his time supervising repacking of pump glands. Then he installed Thomas Flexible Couplings. Now his pumps need no attention.



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1. No Cross-pull on Bearings or Gland.
2. No End-thrust on Bearings or Impeller.
3. Freedom from Backlash—Torsional Rigidity
4. Free End Float
5. Smooth Continuous Drive with Constant Rotational Velocity
6. Visual Inspection in Operation
7. Original Balance for Life—*and*

THOMAS ALL-METAL COUPLINGS HAVE NO WEARING PARTS SO THEY REQUIRE NO LUBRICATION AND NO MAINTENANCE

Write for Catalog 51A

THOMAS FLEXIBLE COUPLING CO.

WARREN, PENNSYLVANIA, U.S.A.

KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

Vacuum Processing Data

Recently increased performance ratings of rotary mechanical vacuum pumps are contained in a revised edition of the 28-page catalog on Microvac pumps for high vacuum issued by F. J. Stokes Corp., 5500 Tabor Rd., Philadelphia 20, Pa.

The new catalog, No. 752, includes, in addition to specifications for the complete line of pumps, tables of formulas, constants, and conversion factors frequently used in vacuum processing; solutions to problems of pump selection for typical vacuum systems; and information on continuous oil purification and other maintenance procedures for high vacuum pumps.

Stainless Castings

The problems of design and construction of fruit juice processing equipment and their solution by means of cast stainless components are discussed in a reprint now available from the Alloy Casting Institute, Mineola, N. Y.

The five-page article includes detailed discussions of four different types of processing operations. In each of these case histories, the equipment containing the stainless castings is fully described, as well as the chemical and physical environment to which the castings are exposed. In addition to ten illustrations, the article includes a chart showing the types of stainless castings commonly used to resist corrosion in the fruit juice processing industry.

General Purpose Press

A four-page bulletin describing the design features and specifications of a new hydraulic general purpose press is available from Watson-Stillman Press Div., Farrel-Birmingham Co., Inc., 300 Aldene Rd., Roselle, N. J.

This new down-acting 150-ton press is recommended by the company for short production runs in metal forming, straightening, coining, forging, light hobbing, and for general testing and die tryout. The bulletin is designated No. 371.

Vertical Pressure Filters

Publications 6319 and 6320, providing details on vertical pressure filters with positive foolproof filter control for use in industrial plants, hospitals, schools, and other institutional and commercial applications, are available from Cochrane Corp., 17th St., Philadelphia 32, Pa.

Publication 6319 describes Type "A" filter and Publication 6320, Type "B" filter. The Type "A" underdrain has a slotted convex or domed diffuser plate welded to the bottom head. This plate is installed at the factory, avoiding the need for field installation of underdrain systems, and it also eliminates the need for concrete sub-fill normally required in other type underdrain designs. The Type "B" underdrain consists of a header lateral system with brass strainers.

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KEEP INFORMED

NEW EQUIPMENT | BUSINESS NOTES | LATEST CATALOGS

Refractory Materials

A two-color, eight-page condensed catalog, RB-20, presenting the firm's line of fired refractory materials has been published by Richard C. Remmey Son Co., Hedley St. and Delaware River, Philadelphia 37, Pa.

Designated as Bulletin RB-20, the new catalog covers 19 standard brands of refractory brick for the steel, ceramics, glass, cement, brick and clay, foundry, heat treating, petroleum, chemical and power industries. The catalog lists the classification, properties and applications of each brand. Also presented are brief descriptions of special refractory shapes; cement, including mortars, ramming mixes, plastics and castables; catalyst carriers, heat exchange pebbles; and and company's line of furnaces and kilns.

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This *new* AIR-FLOW type clutch was designed to provide unusual air cooling qualities. Increased torque capacity is obtained with the Morlife clutch plate. Levers are counterbalanced to eliminate self-engaging tendencies, when the clutch is idling. An unique spring-loaded feature greatly reduces frequency of adjustment. For information how this *new* Rockford AIR-FLOW clutch, with Morlife plate, will improve the operation and increase the on-the-job hours of your heavy-duty machines, write—

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"MORLIFE clutch going strong after 1695 hours, working in sand."

"MORLIFE clutches last 950 hours longer, without adjustment."

"MORLIFE clutch needs adjustment once a month, instead of daily."

"MORLIFE requires lighter handle pull and one tenth the adjustments."

"MORLIFE pulls harder and lasts six to ten times longer."

"Won't buy a unit that isn't equipped with Durable MORLIFE clutch."

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CLUTCHES

Volume Pump

Milton Roy Co. announces the availability of its new Bulletin 1056 on sanitary liquid end controlled volume pumps. This bulletin describes and illustrates the construction of the sanitary liquid end and the ease with which it is disassembled for thorough cleaning. A typical application (syrup metering) is also described.

Copies of the attached Bulletn 1056 are available from Milton Roy Co., Station P, 1300 E. Mermaid Lane, Philadelphia 18, Pa.

Indicators, Recorders

Information about electronic Speedomax H indicators and recorders now available for precise measurement of rotational or linear speeds, and about the tachometer generators used with them, is presented in an illustrated two-page data sheet published by Leeds and Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa.

The sheet lists the features and specifications of the indicators and round- and strip-chart recorders, and tabulates the characteristics and speed ranges of both standard and explosion-resistant tachometers. It is designated data sheet ND46-27(100).

Wire Handbook

A new 120-page manufacturers wire handbook featuring almost 100 types of steel wire is available from Pittsburgh Steel Co., 1825 Grant Bldg., Pittsburgh 22, Pa.

The handbook, presented in an editorial format, contains complete information on wire products made by the company and its subsidiary, Johnson Steel & Wire Co., Worcester, Mass. Sections in the handbook are devoted to cover spring wire, ACSR core wire, strand wire, rope wire, high carbon specialties, shaped wire, wire for cold heading and cold forging, welding quality wire, wire for industry, mill practices and 21 different specialty wires. The latter range from aircraft cord wire to tire bead wire.

Coal Dust Control

Specially engineered systems for controlling coal dust in industrial and utility power plants are described in a new brochure issued by Johnson-March Corp., Philadelphia, Pa. Known as Chem-Jet systems, they are applied wherever coal is handled from receiving point to boiler.

The various handling points are defined and illustrated. The booklet explains how the system suppresses dust at its source and describes the benefits of its use in power plants. A chart shows how small a quantity of surface active wetting solution is required for effective dust control, as compared with the amount of water required. Additional uses for the compound are defined, along with the company's engineering services. A specialized unit is also described for controlling low micron dust and fumes at the breaker buildings and coal bunkers.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Stainless Fasteners

Allmetal Screw Products Co., Inc., 821 Stewart Ave., Garden city, N. Y., has available its eight-page condensed stock list of stainless steel fasteners.

Thirty-seven different basic fastening devices are illustrated in the two-color brochure. Included are screws, bolts, nuts, washers, rivets, pins, and AN specification fasteners. Stock practice according to diameters and lengths is shown in chart form for each fastener type. In addition, data pertaining to threads, head and point styles, and grades of stainless steels is included.

Abrasive Selection Guide

Pangborn Corp., Hagerstown, Md., manufacturers of blast cleaning and dust control equipment, has just issued a new 12-page illustrated manual, No. 333, on the full spectrum of blast cleaning abrasives—their characteristics, application and selection. The work details methods for improving cleaning quality and cutting production costs in foundry, descaling, mold and die, shop maintenance, decorating and carving, part reclamation and finishing operations.

This guide describes the importance of selecting the proper type and size of abrasive, covers abrasive properties and outlines the importance of selecting the correct abrasive for new blast cleaning equipment. The characteristics of Pangborn premium abrasives, including Tru-Steel Shot, Malleabrasive Shot and Grit, Mallan' Steel, Angular Grit and Samson Shot, Diamond Crushed Steel, Jiffy-Blast, and Pangbornite are given. Specifications of soft abrasives such as sawdust, walnut shells, pecan shells and rice hulls are also reviewed. Tables give the sizes and screening specifications of Pangborn abrasives as well as SAE classifications and size designations of shot and grit in a complete range of sizes. Illustrations show typical installations of blast cleaning equipment and a series of photomicrographs demonstrate the differences between shot and grit blasted surfaces.

Plastic Pipe

New Ace Riviclor chemical-resistant plastic pipe, fittings, and valves, are fully described in eight-page bulletin CE-56, which includes technical properties, a table of resistance to chemicals, data on sizes, pressures, and dimensions, and prices for pipe, fittings, and valves from $\frac{1}{2}$ to 2 in. Instructions for threading, forming, and other installation operations are also given.

Ace Riviclor, an unplasticized rigid polyvinyl chloride with exceptional chemical resistance, aging characteristics, and toughness, was developed especially for process piping.

Riviclor Bulletin CE-56 is available on request from American Hard Rubber Co., 93 Worth St., New York 13, N.Y.

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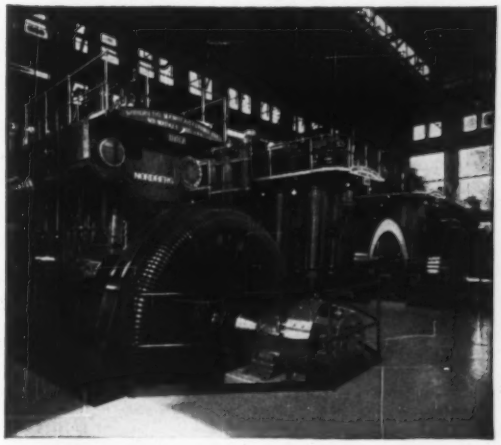

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Steam Heating Specialties

Dunham-Bush, Inc. of West Hartford, Conn., has released a new eight-page catalog illustrating its line of steam heating specialties.

The products include radiator valves, float and thermostatic radiator traps, inverted bucket traps, strainers, air eliminator air checks, and gages for steam, oil, gas and water. Specification data covers dimensions, weights sizes and capacities. The catalog is designed as No. 1501A.

Prefabricated Piping

A 28-page catalog describing prefabricated insulated piping systems, underground and overhead, for steam, condensate, hot or chilled water and other fluids, has been issued by E. B. Kaiser Co., Glenview, Ill.

Information on the design, applications and installation of these systems, including technical data, is included. Designs are listed for simple or multiple inner pipe, casings of flanged cast iron, flanged steel, or welded steel. On-the-job installation is explained with step-by-step diagrams. Fittings and accessories are described.

Instruments, Controls

Products and achievements of Gulton Industries, Inc., 212 Durham Ave., Metuchen, N. J., are discussed and illustrated in a 16-page catalog which breaks down the divisions and associates of the company and describes the products with photographs of each.

Included are the development and production of electro-mechanical, electro-acoustical and electronic devices, instruments, transducers and complete systems; thermistors; precision-built magnetically regulated power supplies; ultrasonic components, systems and consultation service; piezoelectric ceramic materials and ceramic-based electronic components; meters and automatic controls.

Industrial Furnaces

An eight-page two-color gate-fold catalog shows and describes 27 standard rated surface heat treat furnaces available from Surface Combustion Corp., Toledo 1, Ohio.

The bulletin SC-175, illustrates a variety of standard equipment for types of industrial heating applications from small laboratory furnaces to large continuous brazing furnaces.

Switches, Relays

Jaidinger, Mfg. Co., Inc., 1921 W. Hubbard St., Chicago 22, Ill., has issued a catalog showing approximately 40 different switches and relays, ranging in size from standard size units to the miniature, and describing the operation and characteristics of each.

The catalog also shows many of the new developments in switches and relays and gives specifications, size and capacities.

Metal Shapes

Commercial Shearing and Stamping Co. offers a twenty-four page catalog giving factual information on die formed standard metal shapes which are being used and adapted to perform innumerable mechanical functions involving specialized design requirements. A new code analysis and index system provides an easy method to identify the 24 different shapes, and complete tabular data is shown which lists the hundreds of sizes and gages which can be furnished from dies in existence. Copies may be obtained from H. S. Thompson, The Commercial Shearing and Stamping Co., 1775 Logan Ave., Youngstown 1, Ohio.

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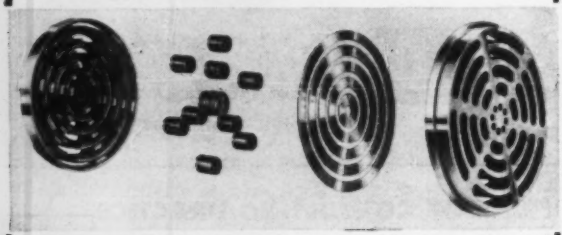

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Special Bulletin:

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Battelle Institute, one of the world's leading independent research organizations, has just published a new booklet describing the varied and unusual career opportunities in its laboratories. Write today for your copy, without obligation, to the Personnel Manager, Battelle Institute, Columbus 1, Ohio.

KEEP INFORMED

NEW EQUIPMENT | BUSINESS NOTES | LATEST CATALOGS

Lock Nuts, Fasteners

Palnut Co., Glen Rd., Mountainside, N. J., has compiled eight pages of data on high speed methods of assembling lock nuts and fasteners with specially-designed wrench attachments, shanks and applicators for use in standard electric, air, "Yankee" and manual drivers.

Included are details of tightening procedures, both manual and power tool, plus descriptions, dimensions and prices of magnetic socket wrenches, internal hex wrenches, magnetic wing nut wrenches, box wrenches and applicators for pushnut fasteners.

Taps, Drills, Gages

Regal Div. Beloit Tool Corp., 12000 Milwaukee Rd., Beloit, Wis., has issued new catalogs covering its line of standard and special taps, drills and gages.

A special feature of the firm's service is 24 hr delivery on many special taps and 10 day delivery on taps manufactured from the customer's blueprint. The new catalogs contain pricing formulas for determining the most economical quantities to purchase.

Electric Hoists

A new four-page, two-color illustrated bulletin, No. H-44, describing electric hoists is available from the Harnischfeger Corp., 4400 W. National Ave., Milwaukee 46, Wis.

The bulletin includes condensed specifications and cut-away photographs of the firm's Hevi-Lift and Zip-Lift hoist line. Especially featured is a new control cabinet, said to have easy accessibility for ease of visual inspection and a simplified design that makes for a minimum of maintenance.

Force Transducers

A two-page bulletin describing Series 140 force transducers is now available on request from Daytronic Corp., 216 S. Main St., Dayton, Ohio.

Included are theory of operation, applications information, photographs, and electrical and physical specifications for the transducers which are based on a combination of the proving ring and differential transformer principles and which are useful for dynamic or static measurement and control involving force, stress, weight, torque, and similar quantities.

Static Speed Control

A four-page publication on static control for paper machines is now available from General Electric Co., Schenectady 5, N. Y.

The bulletin, designated GEA-6275, cites high accuracy, high speed of response, low drift, and highly-dependable performance as the chief characteristics of the new system. It also deals with the space-saving, simplified installation, reduced maintenance, and simplified circuit checking features of the system. In addition, the publication includes a simplified circuit diagram of the system and several photographs.

Solids-Contact Reactors

Cochrane Corp., 17th St., Philadelphia 32, Pa., has released a 24-page bulletin, No. 5001, on solids-contact reactors.

Suppelementing a cut-away photograph are several pages of plan and elevation drawings showing wide variety of designs available. The bulletin discusses theory and problems of cold water clarification, as well as advantages and applications of various designs. Also included is a section on auxiliary and supplemental apparatus.

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	ANALYSIS	RECOMMENDED USE
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KEEP INFORMED

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Fluid Measurement

Bulletin 18RG, released by Schutte and Koerting Co., Cornwells Heights, Pa., describes the company's line of Series 18200 "Safeguard" rotameters as versatile "variable area" type instruments for the accurate measurement of fluid rate-of-flow.

The 12-page two-color bulletin describes rotameter principles and illustrates components common to all such flow measuring instruments. Detailed data on application, construction, operation and installation of "Safeguard" rotameters and pictures describing the various types which make up the complete line, are included.

Engine Case Histories

The first four of a new series of engine case histories have been published by Le Roi Div., Westinghouse Air Brake Co., Milwaukee, Wis. The case histories cover the firm's line of engines from 75 to 675 hp.

The two-page case histories use pictures and drawings to illustrate applications using V-8 and V-12 engines of 540 to 4000 cu-in. size.

Applications include those of air conditioning, gas boosting, cotton ginning and irrigation.

Telesyn Synchros

A 12-page, 2-color brochure describes and illustrates this firm's standard line of Size 1, 3 and 5 Telesyn synchros. Engineered to high military and commercial standards, these units are available as transmitters, receivers, control transformers, and differential units. The brochure provides much application information as well as detailed specifications and performance data, and may be obtained from Ford Instrument Co., Div. of Sperry Rand Corp., 31-10 Thomson Ave., Long Island City 1, N.Y.

Reciprocating Pumps

Data Sheet 100, containing information on 25- to 2400-hp direct flow pumps, is available from Aldrich Pump Co., 30 Pine St., Allentown, Pa.

The four-page, two-color brochure features 3-, 5-, 7-, and 9-plunger reciprocating pumps. It also describes and illustrates the firm's "Power-Savr" pump's stepless, straight-line control of capacity from zero to rated output without any change in speed of power source. Design and material specifications, dimension tables, and a pump selection chart are included.

Aluminized Fence

A four-page bulletin, designated DH-16, has been issued by the Page Steel and Wire Div., American Chain & Cable Co., Inc., Monessen, Pa. Numerous applications of Aluminized Fences as well as special features and styles are listed.

It details a modern addition to the firm's fence line–chain link fence of aluminized fabric and aluminized Albarb barbed wire. The protective aluminum coating, which is bonded to steel wire, will not wash away as it oxidizes but will remain for years of service where abnormal corrosive atmospheres may be present, the firm states.

Powdered Metal Press

Bulletin No. 380 describing the features and specifications of the firm's Model 6-125 powdered metal press is available from Watson-Stillman Press Div., Farrel-Birmingham Co., Inc., 301 Aldene Rd., Roselle, N. J.

The unit is designed for special pressing for producing parts of complicated shape. High production of parts of uniform density is achieved with relatively simple tools, the bulletin states.

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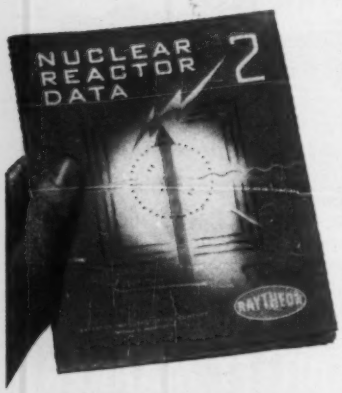

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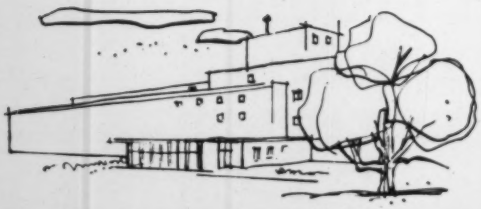

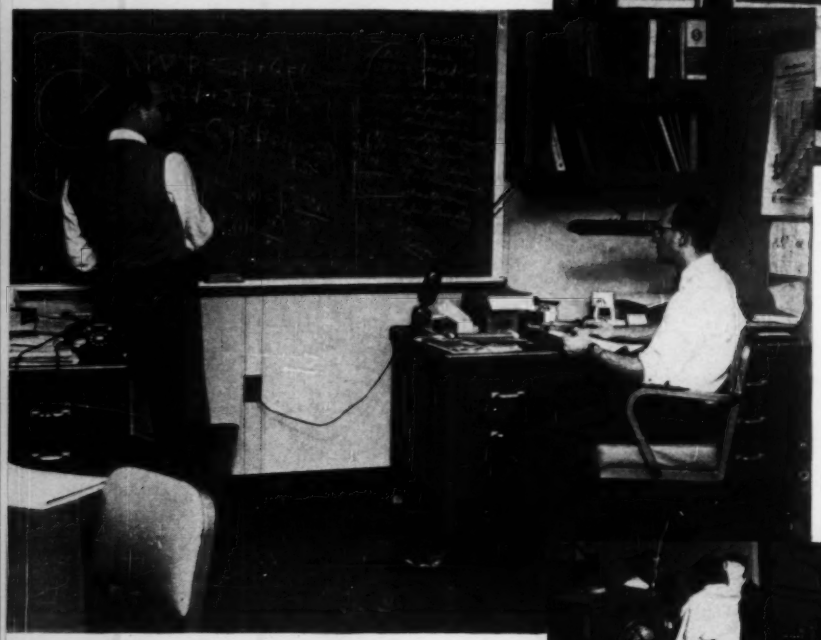

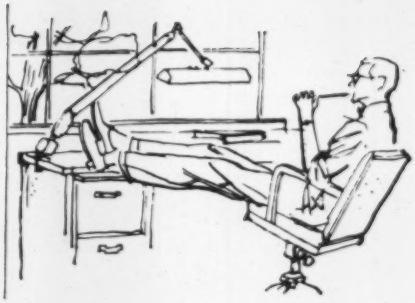

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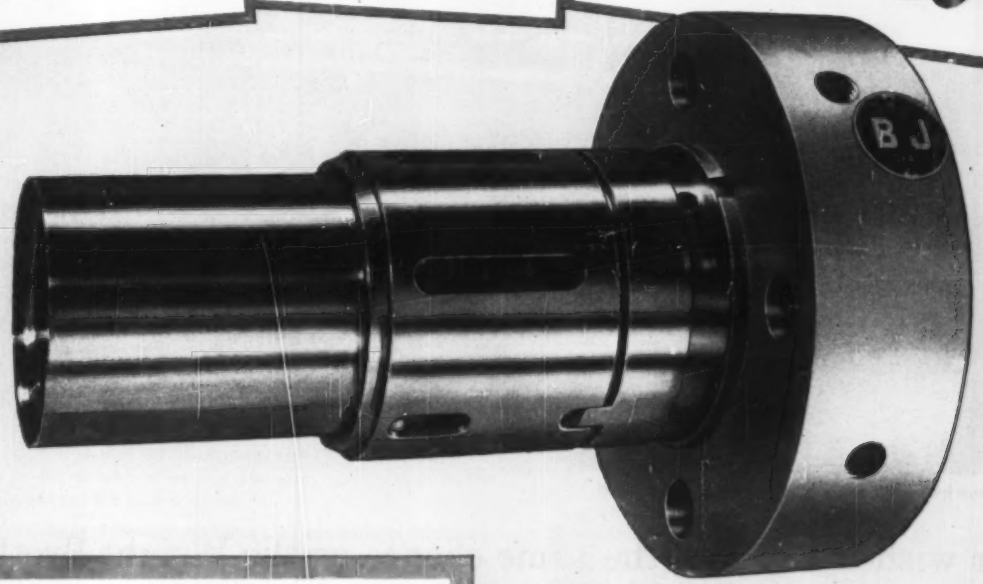

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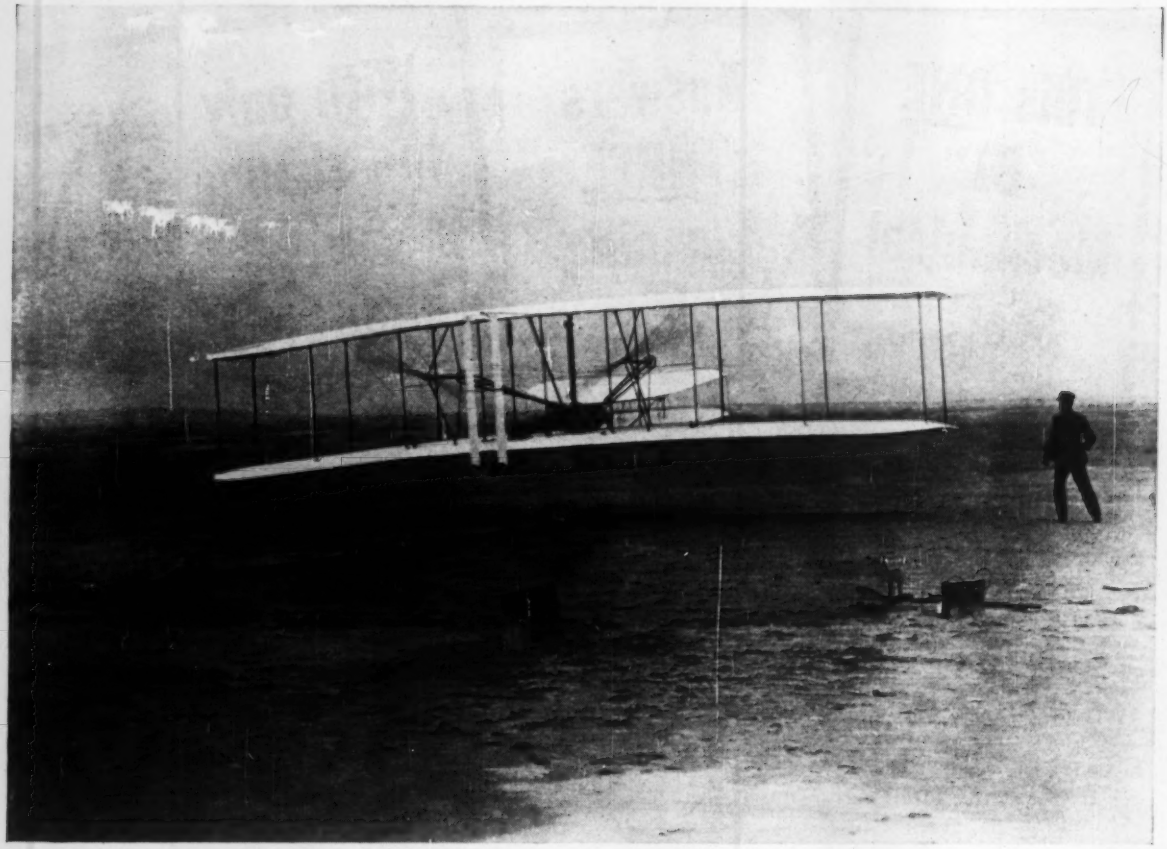

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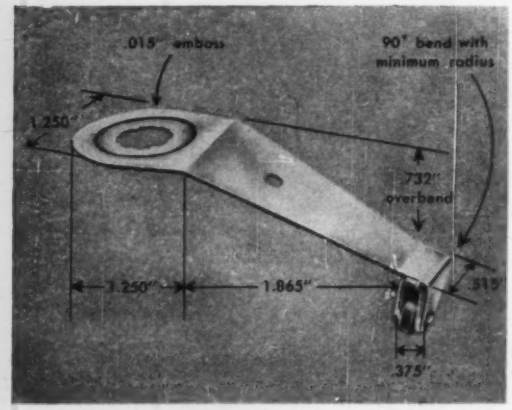

One of the four variable voltage taps in a Type ZW Lionel Trainmaster Control, now made of .0150" thick Duraflex in spring temper. This temper in Duraflex provides the extra strength needed—with the same forming properties as conventional phosphor bronze in extra hard temper.

Lionel switched to DURAFLEX for the hardest working parts of its Trainmaster controls

Much of the fun of model railroading depends on the smooth, dependable performance of its controls. That's why Lionel makes its Trainmaster controls tough, precision instruments – constantly guards their quality.

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First, however, they tried Duraflex*, Anaconda's new superfine-grain phosphor bronze. The fractures were eliminated. The press room found the forming qualities of Duraflex excellent. The Transformer Department was pleased with the reduction in rejects, found the strength and resilience better.

So Lionel has controls of superior quality – at no extra cost – for Duraflex costs no more than ordinary phosphor bronze.

Duraflex, because of its superfine-grain structure, offers greatly improved fatigue resistance and formability. It also has a finer, smoother, harder surface, plus good electrical conducting properties and high corrosion resistance. It is produced in sheet metal up to 0.062" thick and in wire up to 3/16" diameter. We will provide free samples for test purposes – specify gage and temper. Write: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 5666

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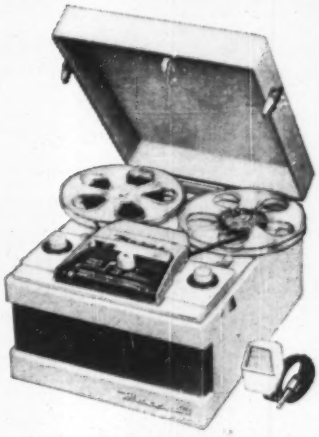
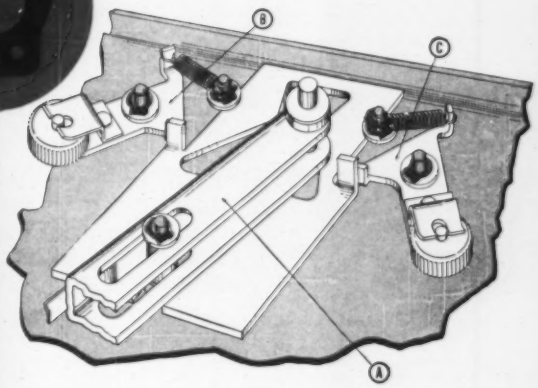
Waldes Truarc grip rings used on die-cast studs eliminate threading, tapping, other costly machining



Mark Simpson Manufacturing Co., Long Island City, N. Y., uses Waldes Truarc series 5555 Grip Rings to secure parts to studs of the zinc die-cast base of its "Masco 500" portable tape recorder.
The rings—which need no grooves—replace nuts, screws, cotter pins and other types of fastening devices which require threading, tapping, drilling and other expensive machining operations. Because a single cracked or broken stud would render the entire cast base useless—and with it, all assembly completed to that point—the rings also eliminate extremely costly rejects.



Pivot Assembly of shift lever (A) is secured by a single Waldes Truarc Grip Ring and washer. Because the washer must be installed over the shift level in a sliding fit, critical tolerances would have to be maintained if a screw or cotter pin were used. The Truarc Grip Ring eliminates that problem: it requires no groove and may be seated over the washer at any point on the stud, automatically compensating for accumulated tolerances in the parts. BRAKE ASSEMBLIES (B and C) use Grip Rings to secure the brake wheel and spring subassemblies. Here again problems of critical tolerances are avoided and expensive rejects eliminated.

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NO reprints of the papers are available but the issues of the magazines in which they are published can be supplied at $1.50 a copy for the ASME TRANSACTIONS ($1.00 each to ASME members) and at 75¢ a copy for MECHANICAL ENGINEERING (50¢ each to ASME members).

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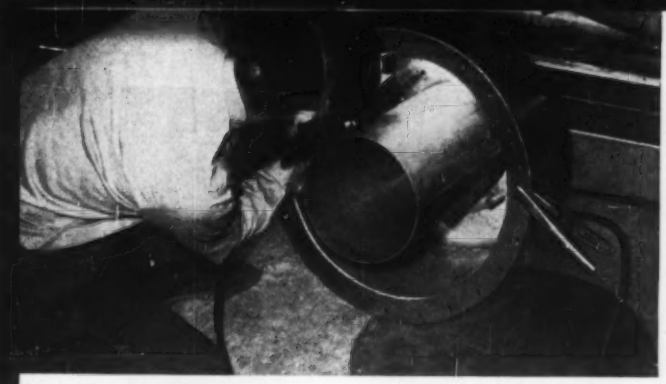

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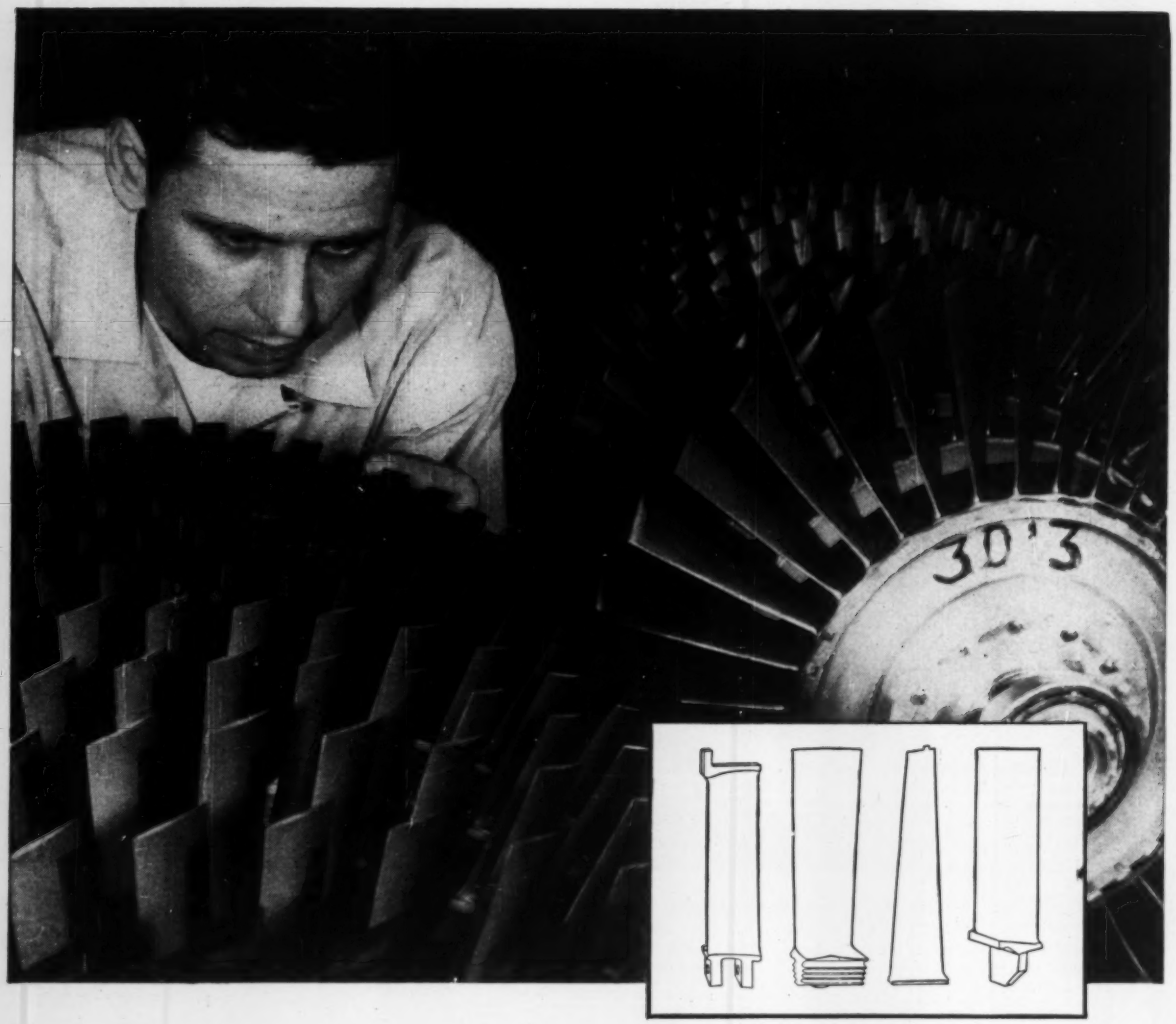

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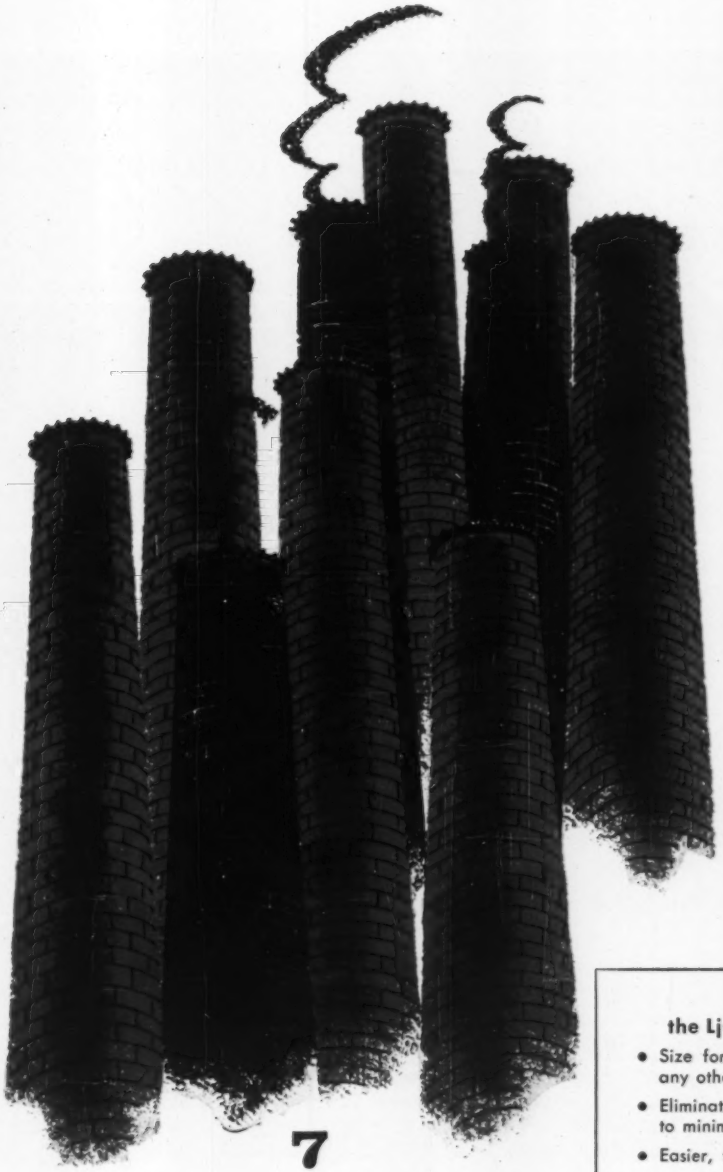

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ENGINEERING BULLETIN

ON MICRO-BEARINGS

Miniature Instrument Ball Bearings

NEW HAMPSHIRE BALL BEARINGS, INC.

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Subject: RADIAL AND AXIAL PLAY

This bulletin explains the interrelation between radial play, axial play and contact angle in small instrument type ball bearings, and assists in specifying these characteristics correctly for typical applications.

DEFINITIONS

Radial play is the maximum possible radial displacement of the inner ring with respect to the outer ring when the bearing is unmounted. *Axial play* is the maximum possible axial displacement of the inner ring with respect to the outer ring when the bearing is unmounted. *Contact angle* is defined as the angle between a plane perpendicular to the bearing axis and a line connecting the two points on a given ball where it makes contact with the raceways under a condition of pure thrust load.

Radial play, axial play and contact angle are geometrically interrelated, but since radial play is the most readily measurable, it is the characteristic usually specified.

In *Fig. 1*, values of axial play resulting from a given radial play and ball size, are given for reference purposes.

SPECIFYING RADIAL PLAY

Two fundamental considerations must be established before arriving at a correct radial play specification: (1) the direction of the load imposed on the bearing, and (2) the axial play control, if necessary for the proper functioning of the unit. This is ultimately a problem of considering the contact angle resulting from a given radial play. High radial play is associated with high contact angle. This relationship is illustrated on *Fig. 2*.

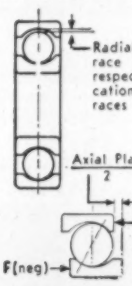
TYPE OF LOAD

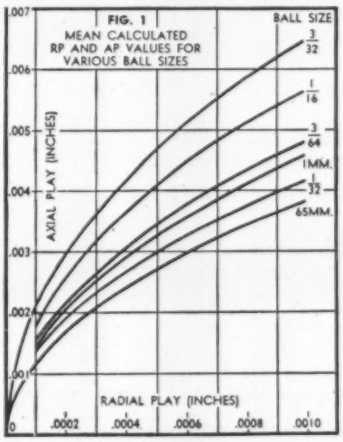
If there is a measurable *axial load*, such as is encountered with bevel gearing, or in an application such as illustrated in *Fig. 3*, the bearings should operate at a high contact angle. Under such circumstances, a radial play of .0005 to .0008 is recommended.

If the application involves a *pure radial load*, such as in the case of spur gears *(Fig. 4)*, there is no concern with contact angle, since it will be zero.

LOW RADIAL PLAY

Functional requirements of the application will dictate whether the radial play is low or standard. However, before *low* radial play is specified, the following factors must be considered:


Radial Play — Maximum distance one race may move diametrically with respect to the other without the application of measurable force when both races lie in the same plane.
Axial Play
F(neg)
Axial Play — The maximum relative axial movement of inner race with respect to the outer, when both races are coaxially centered, without the application of measurable force.
F(neg)



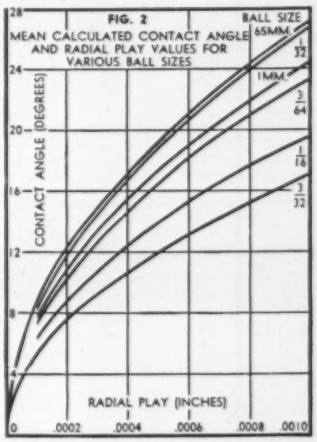


FIG. 5. *Typical Micro-Bearing of the shielded type shown in exploded, cut-away and fully assembled views.*

1. *A bearing with low radial play should not be subjected to interference fitting. This causes reduction in radial play which may create excessive preload resulting in early bearing failure.*
2. *Low radial play results in a low allowable angle of misalignment. An important feature of a ball bearing is its ability to adjust itself internally to possible housing misalignment, particularly when through-boring is not possible.*

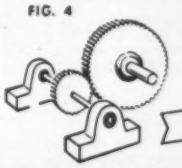
There is one situation, however, where low radial play is recommended. If the bearing is to be subjected to very high repetitious radial shock loads, low radial play minimizes the possibility of bearing damage by distributing the load over a greater number of balls.

AXIAL PLAY CONTROL

If a design calls for axial play values of .002 or less and the bearings are to be used to limit axial travel, it is *not* good practice to achieve this by specifying low radial play. The design should provide for external means of adjustment such as shims. For such cases, the recommended radial play is from .0005 to .0008.

Great care should be exercised if any means other than a calibrated spring is employed to take out *all* axial play. Preloading, with its many complications, may result. Zero axial play automatically yields zero radial play. A high radial play, such as .0005 to .0008, is recommended in cases where axial play is to be reduced to zero by external means.

FIG. 4



Weather vane bearing carries purely thrust load and normally involves high contact angle and high radial play.

Spur gear bearings carry a purely radial load where contact angle is zero.

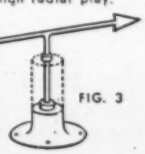


FIG. 3

RADIAL PLAY SPECIFICATION

There is a misconception among many bearing users that radial play is automatically considered under the ABEC classification. Such is not the case.

However, standard "MICRO" bearings are assembled with a radial play of not less than .0002 nor greater than .0008, unless so ordered. If this range of .0002 to .0008 is acceptable in the application, it is recommended that *No Radial Play Specification* be placed on the bearing.

Radial play is specified most conveniently by a tolerance range. Thus, while the radial play of a given bearing might be .00036, it is more convenient to represent this value as .0002 to .0005. Detailed instructions for specifying other than standard radial play values are incorporated in our catalog.

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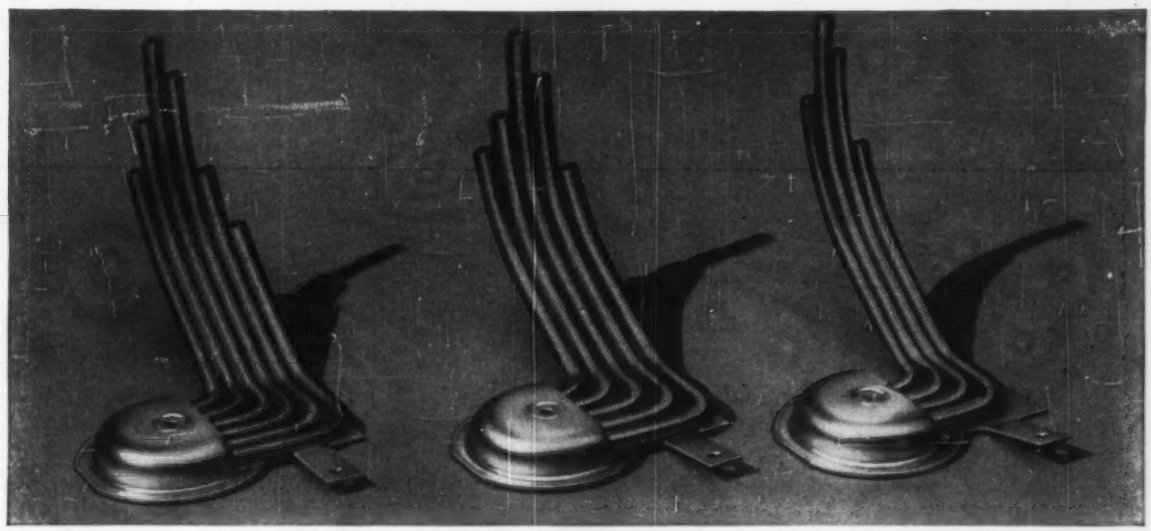

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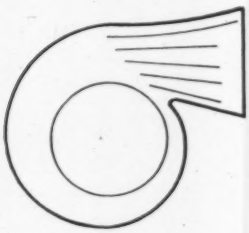

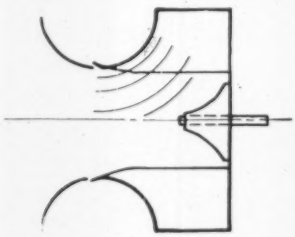

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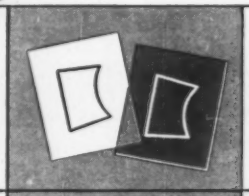

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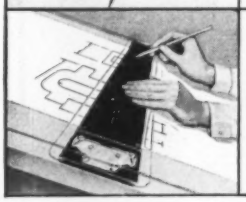

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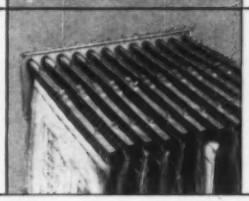

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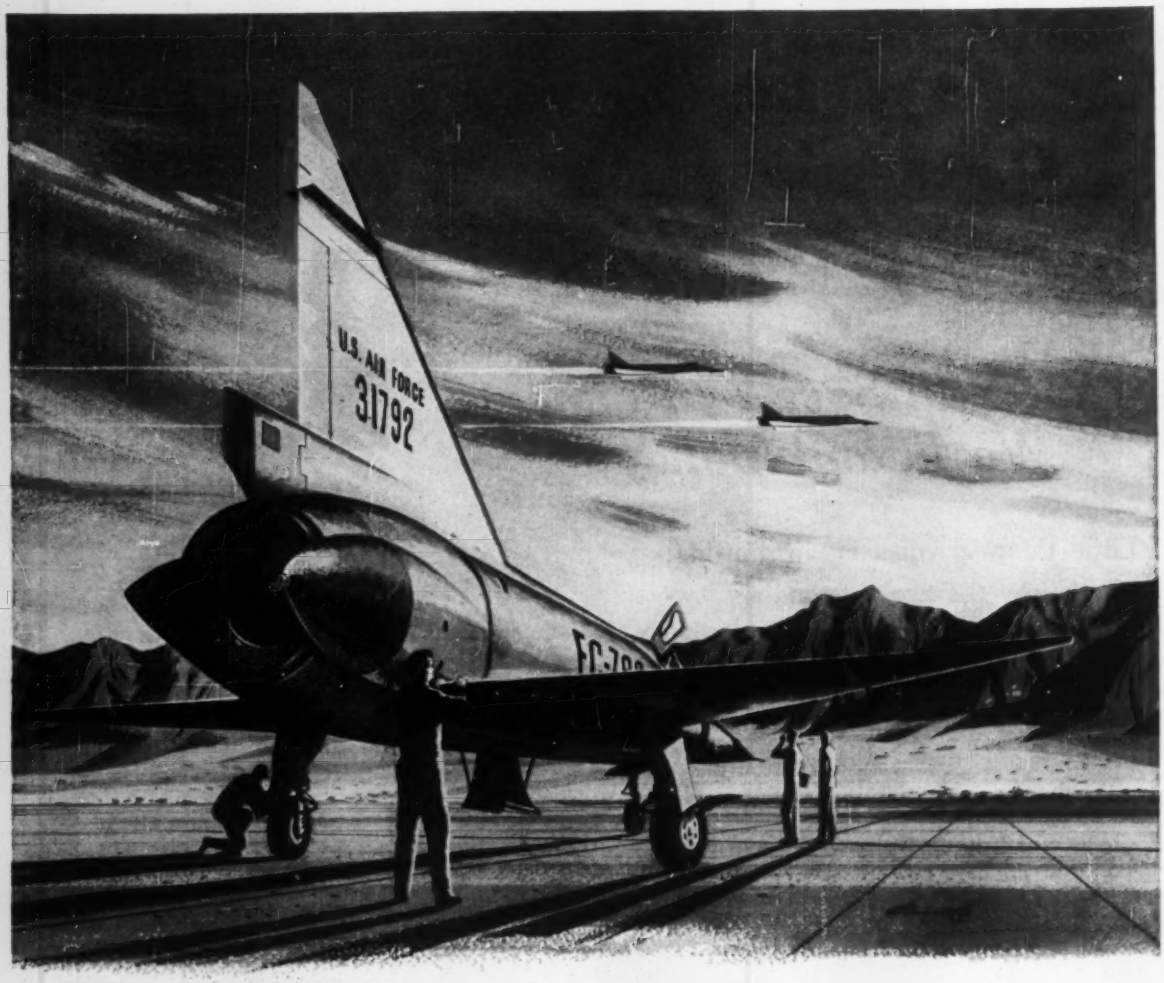

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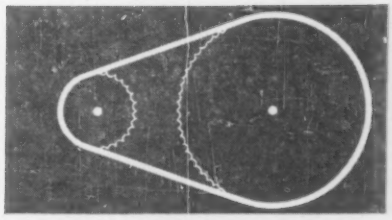

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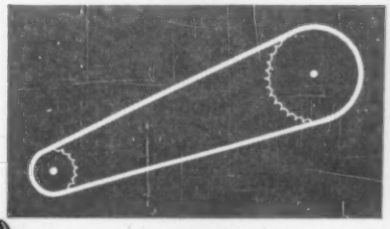

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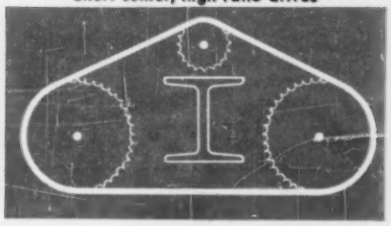

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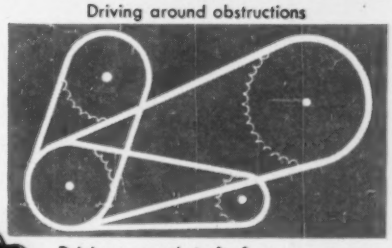

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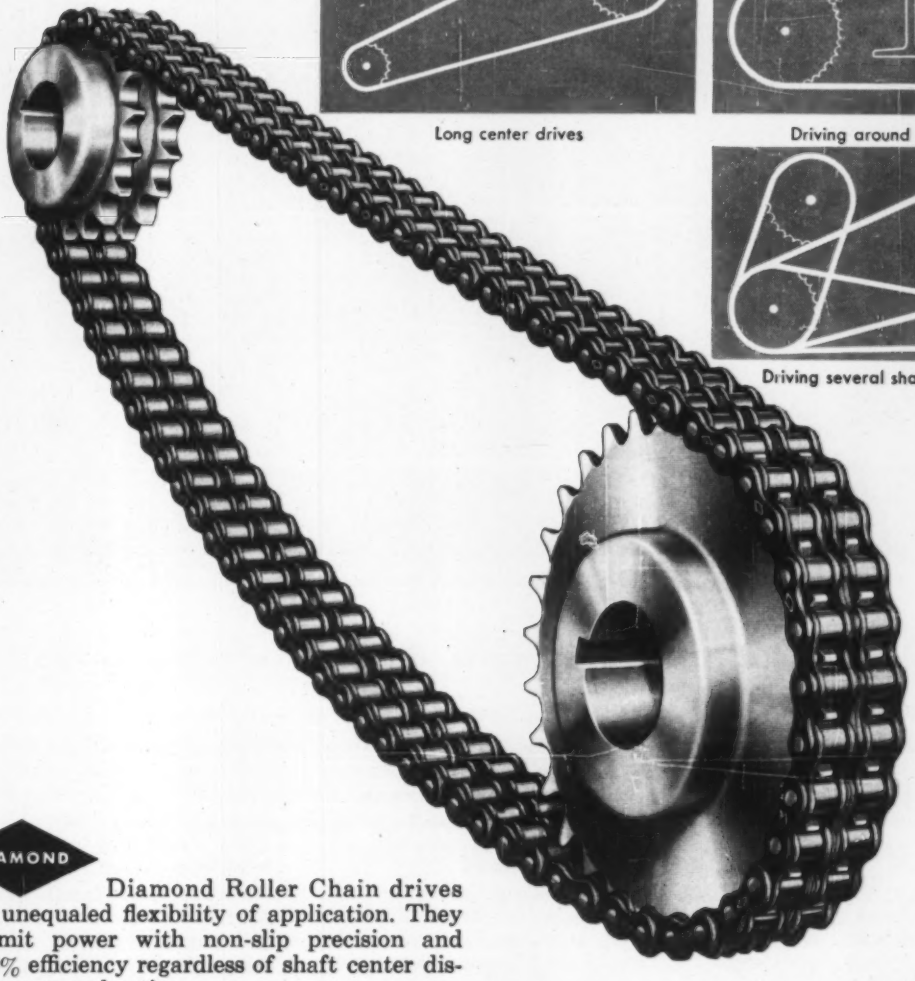

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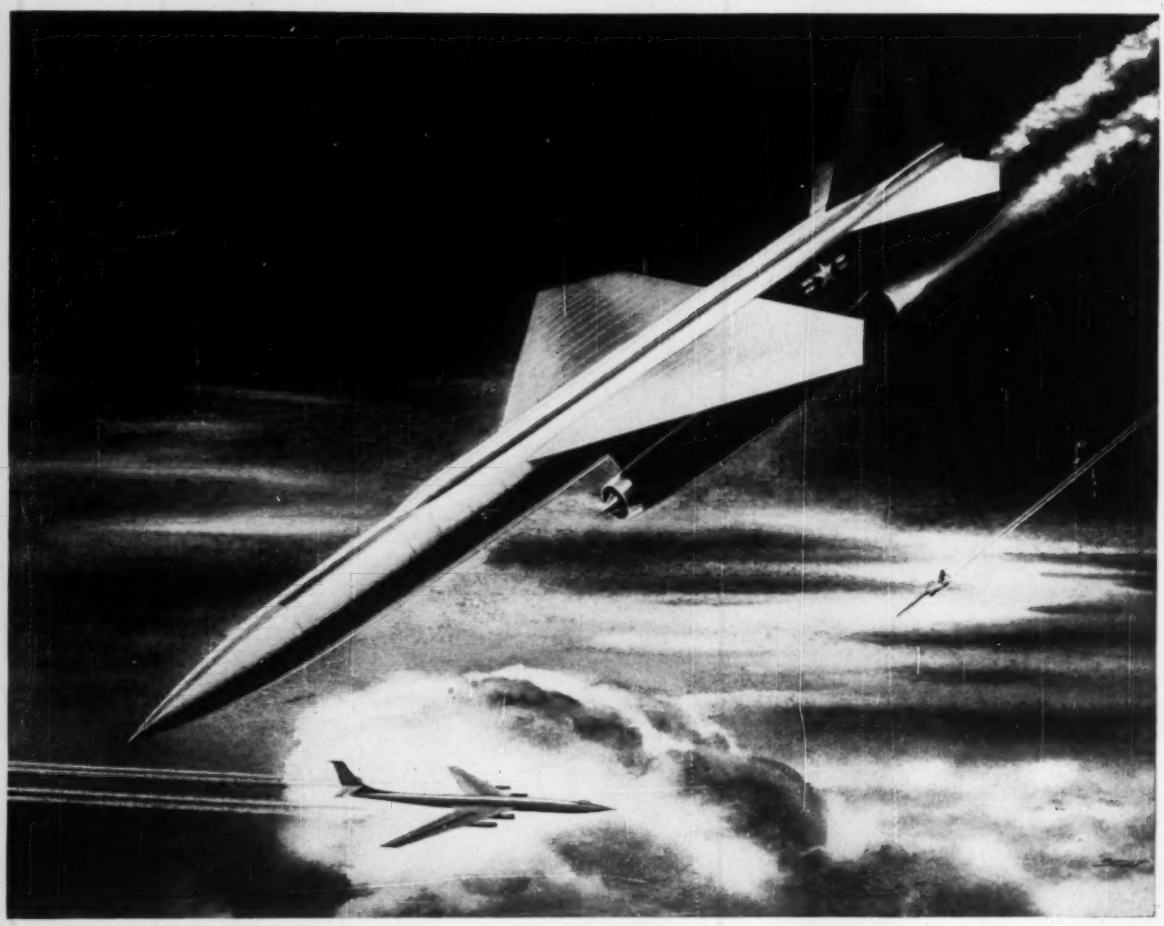

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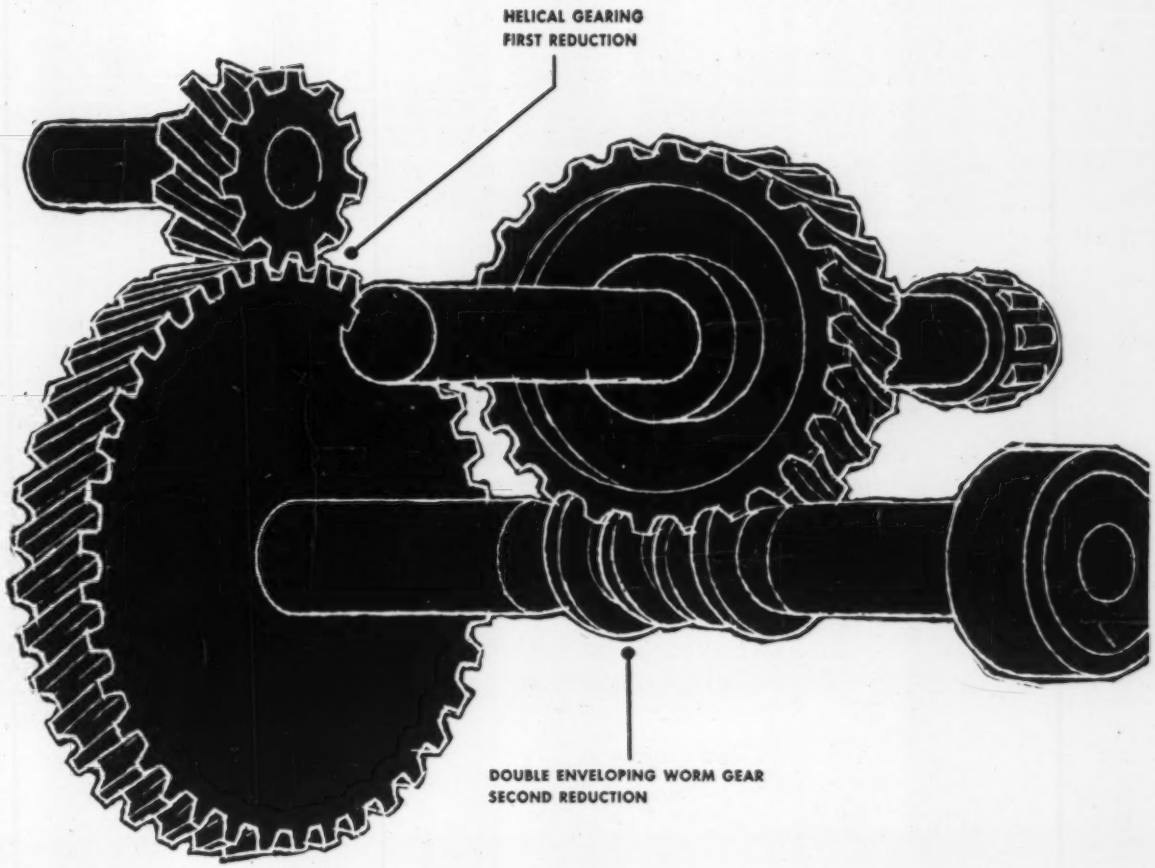

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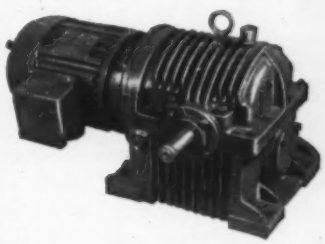

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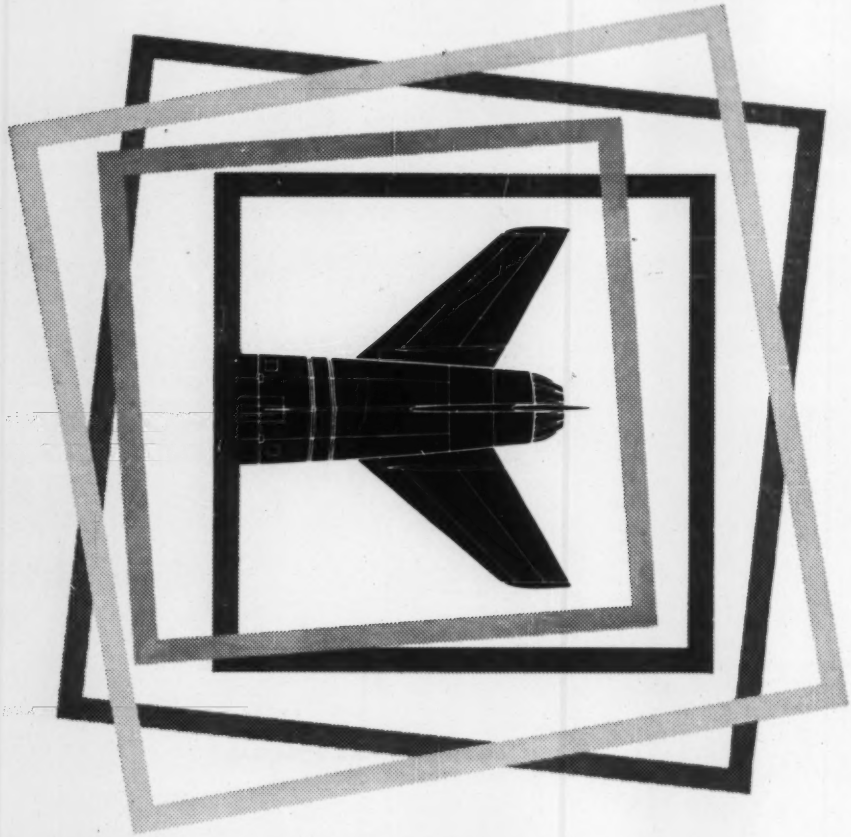

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You can accelerate your own career considerably by working with us on some of the most advanced problems in the aviation industry—the problems of high performance aircraft, supersonic and hypersonic designs of the present and the future.

This high speed research includes design and test in Vibration, Aeroelastic and Flutter analyses, analog and digital computer techniques in Electronics, and many more.

The opportunities at North American, Los Angeles Division, are many and varied. You work surrounded by activities of a highly interesting nature, using facilities of the most advanced type. You'll enjoy wide scope for your talents, and you'll particularly like the climate of individualism and team spirit that exists. Your associates will be people who respect your opinions and professional status. Check the openings listed below.

OPENINGS ARE IMMEDIATE. PROFESSIONALLY QUALIFIED WOMEN ARE WELCOME

Recent Aeronautical Engineering Graduates • Recent Mathematics Graduates (Women) • M. E. Graduates with Vibration Experience • Recent Electrical Graduates, for Lab. work • Experienced Flutter Engineers (Aeronautical, Mechanical Engineers, Physicists, Mathematicians) • Experienced Vibrations Engineers • Experienced Instrumentation Engineers, electrical background • Experienced Analog or Digital Computer Engineers, either Electrical, Mechanical or Aeronautical Engineers, or Physicists. Heavy analog experience desirable.

ALSO NEEDED: Aerodynamicists, Systems Engineers, Instrumentation Engineers, Aero-Thermodynamicists, Aeroelastic Engineers, Cycle Analysis Engineers

Contact Les Stevenson, Engineering Personnel Office, Dept. 56-12 ME
North American Aviation, Inc., Los Angeles 45, California

North American Aviation, Inc. is doing research and development on the X-15, a manned aircraft for investigation of speeds and temperatures at very high altitudes.

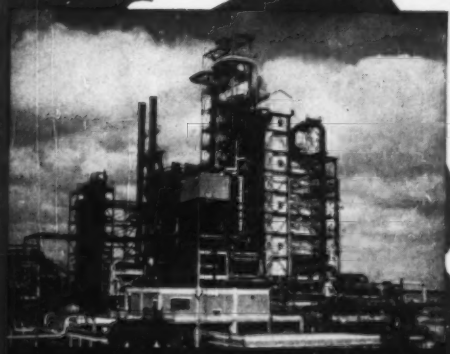
Los Angeles Division

NORTH AMERICAN AVIATION, INC.

NORTH AMERICAN HAS BUILT MORE AIRPLANES THAN ANY OTHER COMPANY IN THE WORLD

DROP FORGED STEEL

valves, fittings and flanges by Vogt



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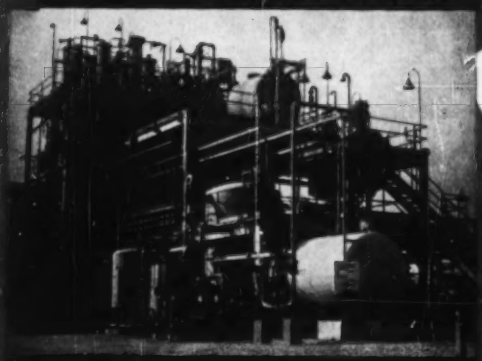
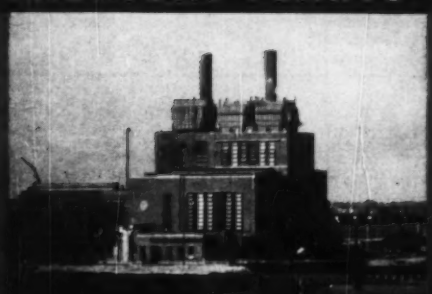


CHEMICAL PLANTS



POWER PLANTS

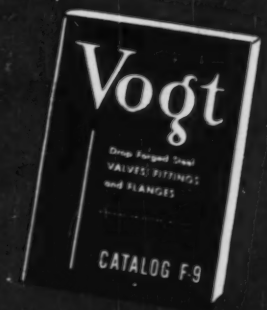
USED and TRUSTED by the NATIONS KEY INDUSTRIES

There are good reasons behind the trust which America's key industries have placed in Vogt valves, fittings, and flanges for half a century. They know that *drop forged materials* are uniform in structure, fine grained, and free from porosity. They know, too, and appreciate the meticulous care given these products through every stage of forging and machining in Vogt's modern shops, and about the many rigid tests and inspections. And that is why these products enjoy such an impressive record of performance in withstanding the shocks and stresses imposed by high or low pressures and temperatures and in resistance to erosive and corrosive conditions.

Service is another important factor in this confidence because Vogt maintains the world's largest and most complete stock of drop forged steel valves, fittings, and flanges always ready for immediate shipment.

Write for Catalog F-9. Consult its 400 pages for the complete Vogt line of drop forged steel valves, fittings, and flanges for oil, steam, water, air, gas, and refrigeration services.

Address Dept. 24A-FM



HENRY VOGT MACHINE CO. 75th Anniversary LOUISVILLE, KY.

HENRY VOGT MACHINE CO., LOUISVILLE, KY.

SALES OFFICES: New York, Philadelphia, Chicago, Cleveland, Cincinnati, St. Louis, Dallas, Charleston, W. V., San Francisco

Delta Air Lines Gives $225,000 Bonus in U. S. Savings Bonds

C. E. WOOLMAN
President and
General Manager
DELTA AIR LINES

Delta Air Lines, Inc.

GENERAL OFFICES · ATLANTA AIRPORT · ATLANTA, GEORGIA

TO: All Members of Delta Family

FROM: President and General Manager

This has been a difficult but successful year. Each of us has had a hand in our accomplishments.

Again we want to share our good fortune with all our people and it is a pleasure to announce that all personnel with more than six months of service as of May 24, 1956, will receive a $50.00 U.S. Savings Bond. All personnel with six months of service or less as of that date will receive a $25.00 U.S. Savings Bond. The total value of these bonds will be about $225,000.00.

The bond is both a share in our achievements and an added expression of appreciation for your contribution to them.

C.E. Woolman

Delta

If you are wondering whether *your* employees would prefer Savings Bonds to Cash . . . take a quick glance at these figures:

. . . 8,000,000 Americans enrolled in the Payroll Savings Plans of *40,000* companies invest $168 Million *per month* in U. S. Savings Bonds.

. . . 40,000,000 Americans hold $41 Billion (cash value) in Series E and Series H Savings Bonds . . . a huge reservoir of future purchasing power.

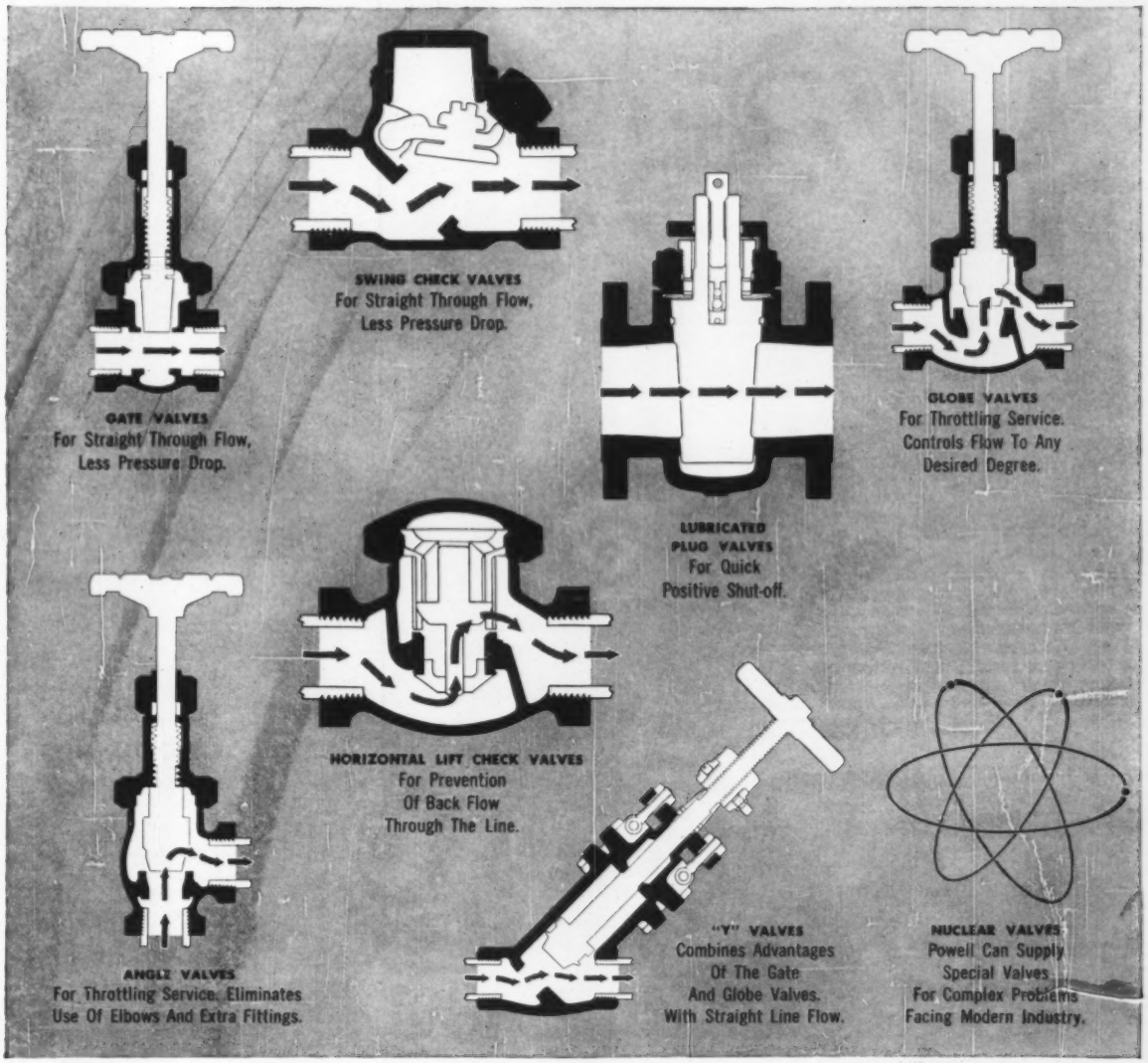
. . . 67% of *all* Series E Bonds that matured up to June, 1956—more than $21 Billion—are being held by their owners under the automatic extension program.

Join Delta Airlines—and many other fine companies—give your Bonus in Bonds—the gift that grows. Savings Bond Division, U.S. Treasury Department, Washington 25, D. C.

The United States Government does not pay for this advertising. The Treasury Department thanks, for their patriotic donation, the Advertising Council and

MECHANICAL ENGINEERING

POWELL
for all valve needs



for every flow control problem there is a right Valve

Powell can supply this right valve—*made right* of the right material*. Every part of every valve must pass rigid inspection. And as a final step in manufacture, every Powell Valve has *Performance Verified* through an *actual line test.*

As an aid in selecting the right valve, the basic valve designs are illustrated here. For complete information on the wide range of sizes and materials available in each type of the basic valves illustrated above, consult your Powell Valve distributor. If none is located near you—or if you have a special flow control problem—write direct to The Wm. Powell Company, Cincinnati 22, Ohio.

PERFORMANCE
PV
VERIFIED

The Wm. Powell Company, Cincinnati 22, Ohio . . . 110th YEAR

POWELL VALVES

*BRONZE, IRON, STEEL AND CORROSION RESISTANT VALVES.

Engineers, when in New York, are saying:

UNEXCELLED OPPORTUNITIES for ENGINEERS

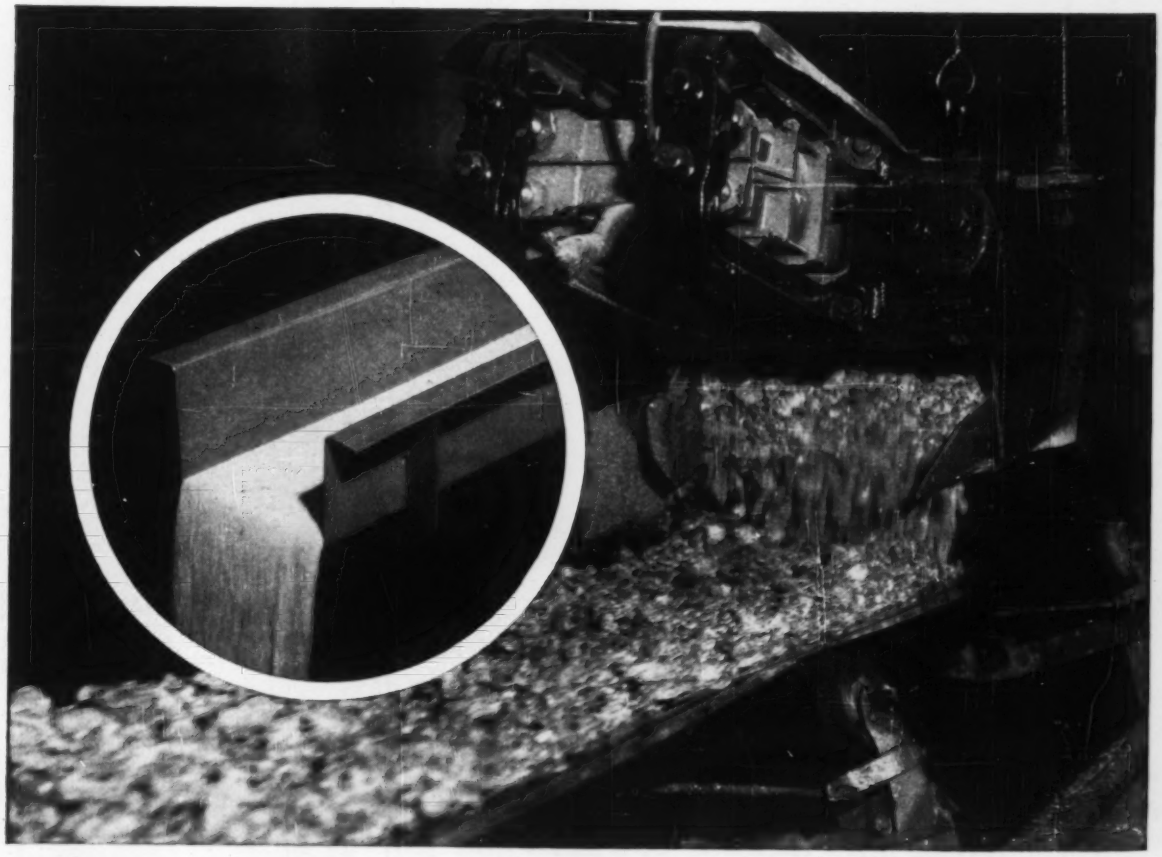
- DESIGN
- CHECKING
- METALLURGY
- DEVELOPMENT
- VIBRATION
- ANALYSIS

They are taking the opportunity to visit

HAMILTON STANDARD'S New York Engineer Interview Headquarters

Don't neglect the opportunity to discuss your future with the Hamilton Standard interviewer at our New York offices in the Governor Clinton, 7th Avenue at 31st Street. Drop in any day, Monday through Saturday, between 10 a.m. and 7 p.m., or to arrange a confidential interview, call W. H. Brownell at PEnnsylvania 6-3400. Discover the many benefits of investing your talents with this expanding leader in the jet aircraft equipment industry.

HAMILTON STANDARD, Div. of United Aircraft Corp., Windsor Locks, Conn.



Jeffrey puts VIBRATION to useful work

You can solve many problems of conveying solid materials with Jeffrey Electric Vibrating Feeders. Move fine powders or huge stone blocks . . . a few ounces or two thousand tons per hour . . . dripping wet or bone dry . . . at temperatures ranging from 30° below zero to 2,000° above. Materials are propelled in a smooth, continuous stream by each forward vibration stroke.

Balanced vibration in the Jeffrey system matches electrical frequency to natural mechanical frequency of the driven equipment. This makes the system highly economical to operate, since all available energy does useful work. It is easy to control, safe, quiet and dependable. Vibration is scientifically isolated within the conveyor.

Jeffrey's years of experience with conveying problems enable us to furnish systems exactly right for each particular task. Catalog 870 describes the complete line of Jeffrey Vibrating Equipment. For a copy, and for help on your conveying problems, write The Jeffrey Manufacturing Co., Columbus 16, Ohio.

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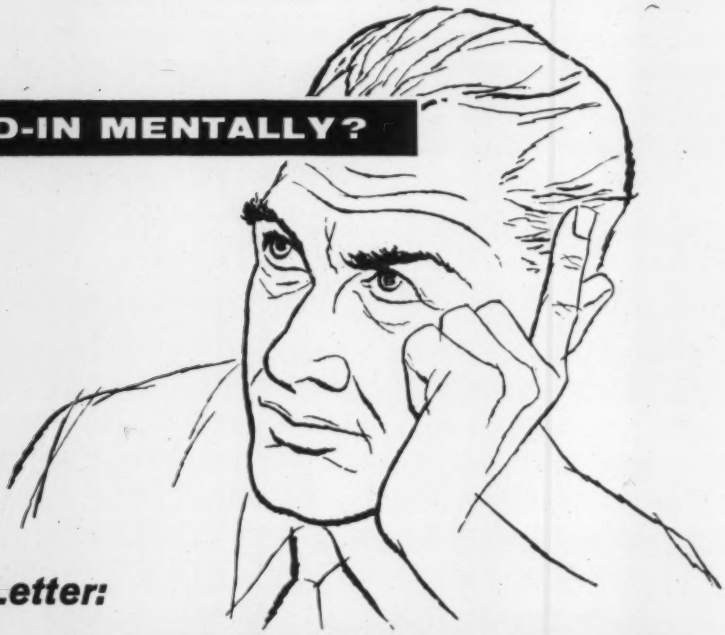
BOXED-IN MENTALLY?



An Open Letter:

TO ENGINEERS, SCIENTISTS AND MATHEMATICIANS

Who Are Thinking of the Future

Whatever Your Past Experience... There's a Place for You in Atomic Energy at B&W

Take stock of yourself . . . your job . . . your living conditions. If you're boxed-in mentally; if your future looks dim; if you're living somewhere west of nowhere, or in a crowded city—or an outlying suburb—now is your chance to get out and better yourself. Get in atomic energy. Enjoy an interesting job and live in Lynchburg—the heart of Virginia's Blue Ridge country.

There's plenty of elbow room right now in atomic energy at B&W. There's plenty of room to grow, as so many of our men have discovered. This is the place and the field to consider, if—like most men with your education and background—you're thinking about your future.

HERE IS A NEW FRONTIER—for you at B&W. And you don't need specific nuclear experience to take advantage of the opportunities. If you have training or experience in any of the following fields, there's a job waiting for you at B&W in which you can fruitfully apply your talents.

Mechanical Engineering • Physics • Chemistry • Mathematics Civil Engineering • Chemical Engineering • Electrical Engineering • Engineering Physics • Fuel Technology • Metallurgy • Metallurgical Engineering • Nuclear Engineering

THERE'S AN EXTRA PLUS, TOO. Fine living conditions in a clean city with excellent schools—and the friendliest sort of people for neighbors.

B&W's engineering research and development background spans nearly 100 years. We've been active in atomic energy from the beginning — at Oak Ridge, Los Alamos and Hanford. We're working today on a variety of projects—designing and building the first privately owned nuclear power plant, pioneering in research reactors at home and abroad, developing a pressurized-water reactor for the first nuclear-propelled cargo vessel.

Atomic energy is in its infancy. The opportunities for personal and professional recognition are great. You can become part of the group of engineers, scientists, and mathematicians who truly are writing the rules, paving the way for those who come after you in this great field. It's like being at Kitty Hawk with the Wright Brothers. You're on the ground floor with B&W and you can grow with the field.

TODAY is the day to take that step toward building your future. If you like new and different problems, we have the job for you. The Babcock & Wilcox Company, Atomic Energy Division, 161 East 42nd Street, New York 17, N. Y.

PE-19-AE

Write for literature describing some of B&W's atomic energy activities or send resume to: Personnel Department, ME-12, Atomic Energy Division, The Babcock & Wilcox Company, 161 East 42nd Street New York 17, N. Y.

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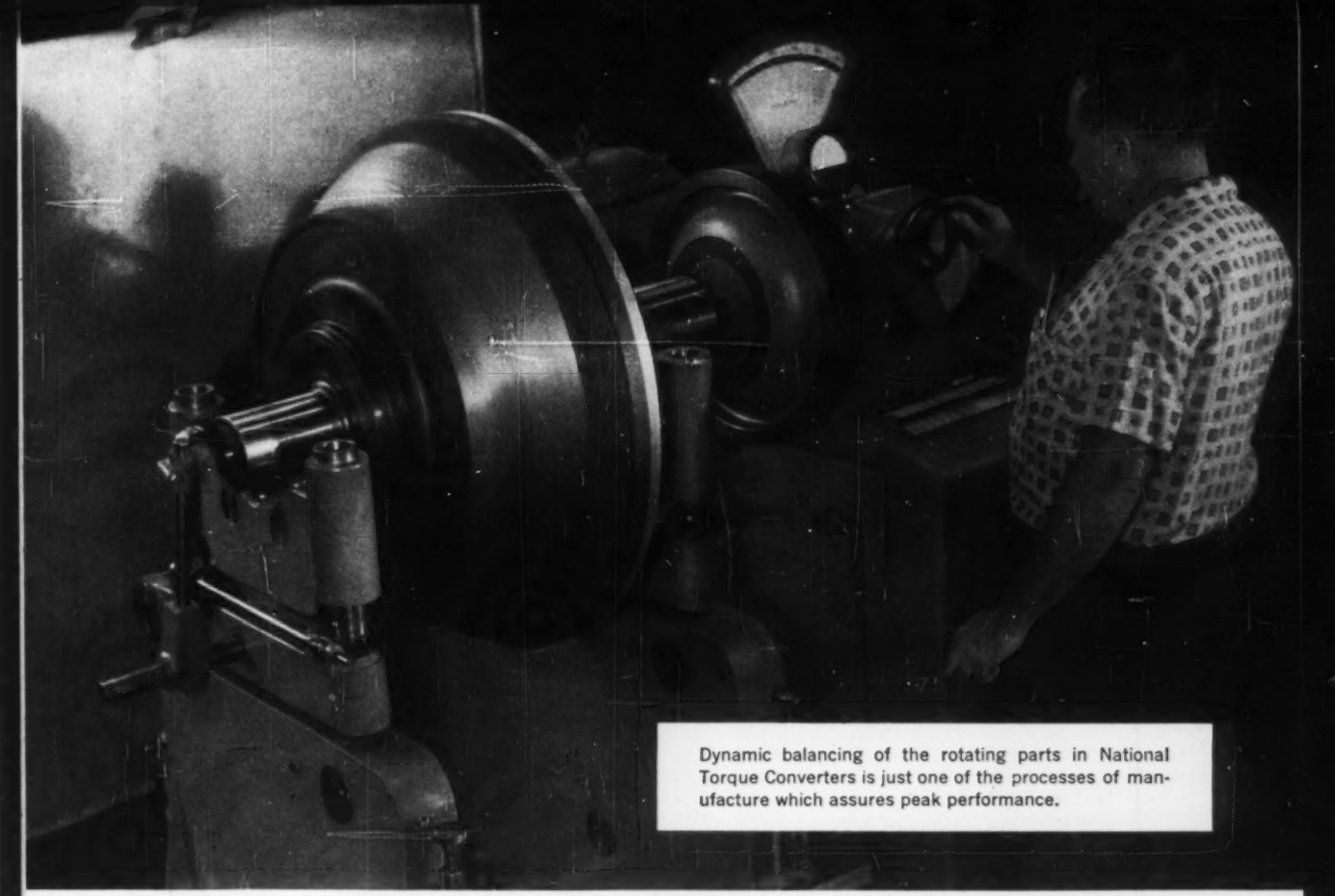
ATOMIC ENERGY DIVISION



Dynamic balancing of the rotating parts in National Torque Converters is just one of the processes of manufacture which assures peak performance.

Dependable heavy-duty performance is engineered and built into National Torque Converters

Heavy machinery demands exceptional torque converter performance. Examples of this are earth-handling and excavating equipment, mining, and oil field drilling equipment.

To meet the most exacting service demands, in a wide variety of industrial applications, a full line of heavy duty National Torque Converters are available. These are designed and built with a broad range of performance characteristics and in horsepower ratings to match torque converter to prime movers of 100 to 1000 hp in virtually any application. The torque converters are engineered for the specific equipment application.

Precision fabrication of parts . . . exhaustive tests of component parts, of sub-assemblies, and of complete torque converters . . . assure long, trouble-free service of each National Torque Converter, with a minimum of attention from the operator and with minimum expense to the owner.

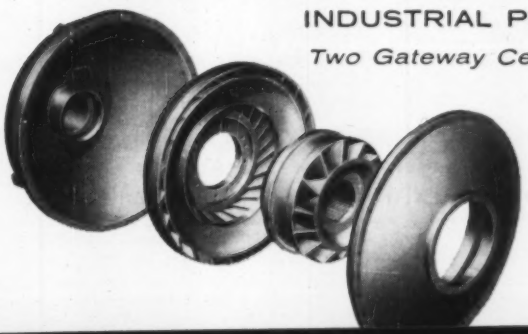
That means that when you select a National Torque Converter to match a specific engine or motor in a specific application, you can be sure of duplicate results from each succeeding National Torque Converter engineered and built to the same specifications.

National Supply engineers will gladly discuss National Torque Converters in relation to your equipment and make recommendations of exact size and torque capacity. Why not call on them?

THE NATIONAL SUPPLY COMPANY

INDUSTRIAL PRODUCTS DIVISION

Two Gateway Center, Pittsburgh 22, Pa.



Pace-setters in the progress of industrial power transmission

IMPORTANT DEVELOPMENTS AT JPL

Integrated Teamwork in Missile Development

The Jet Propulsion Laboratory is a stable research and development center located north of Pasadena in the foothills of the San Gabriel mountains. Covering an 80 acre area and employing 1600 people, it is close to attractive residential areas.

The Laboratory is staffed by the California Institute of Technology and develops its many projects in basic research under contract with the U.S. Government.

Opportunities open to qualified engineers of U.S. citizenship. Inquiries now invited.

One of the most significant aspects of the Jet Propulsion Laboratory's progress has been its ability to develop an outstanding staff of engineers and scientists of top talent and ability. Prompt recognition of individual ability and initiative supported by authority to act has been, and is, an important factor in forming this progressive and productive research and development team.

These men, though individually responsible, work as a thoroughly integrated team on all aspects of the entire missile system instead of concentrating only on specialized missile components.

Since this includes development projects involving design, structure, propulsion, guidance, ground handling, etc., which are constantly influenced by continuing Laboratory research, the comprehensive program contains sufficient problem areas to challenge individuals of practically any phase of engineering interest.

The fluid character and constant progress of such activities at the Jet Propulsion Laboratory provide a stimulating attraction to qualified people interested in pioneering in basic research, applied research and also in actual development engineering.

JOB OPPORTUNITIES IN THESE FIELDS NOW

jpl

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DYNAMICS • PROPULSION
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JET PROPULSION LABORATORY

A DIVISION OF CALIFORNIA INSTITUTE OF TECHNOLOGY

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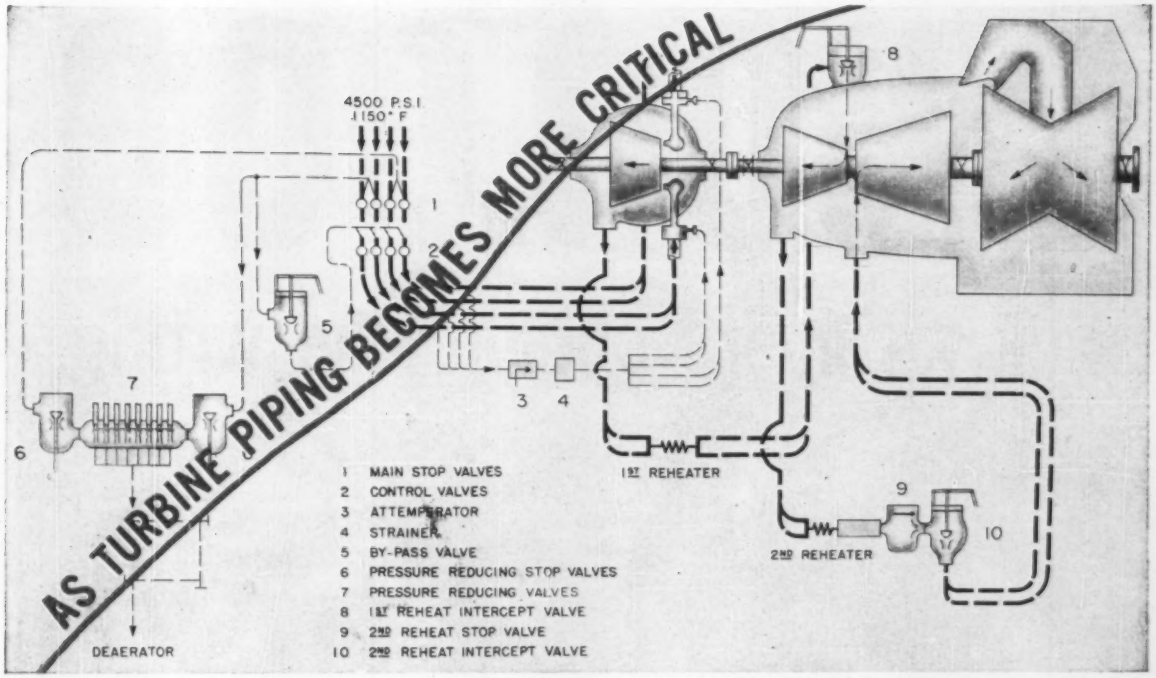

Schematic steam-flow diagram of the General Electric 125,000-kw turbine-generator unit at Ohio Power Company's Philo plant

Kellogg Engineering and Fabrication Keep Pace

The General Electric 4,500 psi, 1,150 F steam turbine at Ohio Power Company's Philo plant is a major advance in high pressure-high temperature design. Piping on the turbine typifies M. W. Kellogg's service to power generating equipment manufacturers and to the electric-utility industry.

All of the turbine high-temperature steam and control piping for this 125,000-kw General Electric unit was furnished by The M. W. Kellogg Company. Kellogg's responsibility included: the purchase of materials—largely Type 347 stainless; the development of individually tailored welding techniques; fabrication; and rigid testing and inspection procedures.

Scope of this assignment is illustrated by the work involved in fabricating the main steam piping, using Type 347 stainless. The piping was examined for physical soundness by circumferential, radial, and axial ultrasonic testing. Also, in order to determine if minimum wall thickness had been maintained throughout, the piping was measured by the Audiogage every 6 inches before and after bending. Twenty-six joints were welded with Kellogg's K-Weld* technique. All welds were given 4 red dye checks and X-rayed. In addition, the piping was hydrotested at 9,000 psi, and solution heat treated at 1,925 F.

The M. W. Kellogg Company welcomes the opportunity of applying its engineering and fabricating knowledge to the specific supercritical steam problems of consulting engineers, engineers of power generating companies, and manufacturers of boilers, turbines, and allied equipment.

FABRICATED PRODUCTS DIVISION
THE M. W. KELLOGG COMPANY, 711 THIRD AVENUE, NEW YORK 17, N. Y.
A SUBSIDIARY OF PULLMAN INCORPORATED

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POWER PIPING—THE VITAL LINK

**Trademark of The M. W. Kellogg Company*

2,500,000

sink strainers couldn't be wrong

Strainer is [illegible] gauge [illegible] Revere Leaded Brass Strip drawn to a depth of 2½".

MICHIGAN BRASS Company saw to that by using REVERE Leaded Brass Strip

Michigan Brass has a reputation for making only quality plumbing goods. So the material for their sink strainers had to be good to start with and remain consistently so over the years. After making over two and a half million strainers from Revere Leaded Brass Strip they tell us that not only has their quality for this item been consistent, but they also have realized certain savings in production.

Here's why they use Revere Leaded Brass for their strainers:

1. The inherent corrosion resistance of brass. 2. Its deep drawing characteristics (Photo at left above shows strainer after it has been blanked and drawn in progressive die). 3. Ease of machining large diameter threads with leaded brass. 4. The excellent surface that can be developed for chrome plating (Photo above right shows strainer after it has been trimmed, dimpled, threaded and plated). 5. The consistent uniformity and quality of Revere Leaded Brass Strip over the years.

These very same characteristics of Revere Leaded Brass Strip may be the very ones that could help you retain the quality of your product over the years . . . cut your production costs. Why not have a chat with a Revere TA (Technical Advisor) and see? It costs you nothing . . . may save you plenty.

COPPER ★ BRASS ★ 1801 ★ REVERE ★ ALUMINUM

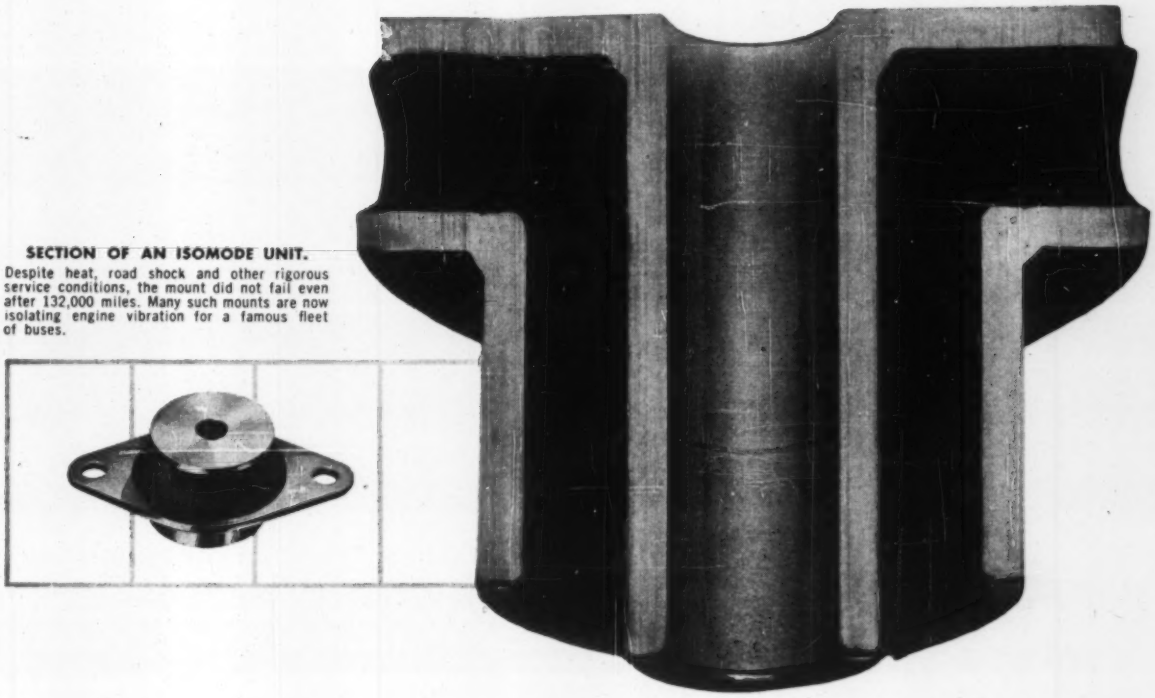
REVERE COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, N. Y.

Mills: Baltimore, Md.; Brooklyn, N. Y.; Chicago, Clinton and Joliet, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Newport, Ark.; Rome, N. Y. Sales Offices in Principal Cities, Distributors Everywhere.

MB engine mount proves good for 132000 miles!



SECTION OF AN ISOMODE UNIT.
Despite heat, road shock and other rigorous service conditions, the mount did not fail even after 132,000 miles. Many such mounts are now isolating engine vibration for a famous fleet of buses.

Above you see a section of an Isomode® type 5 vibration isolator after 132,000 miles of bus service. Breaking an endurance record, the mount could easily have gone to 150,000 miles.

It takes an extremely *rugged* mount to survive the countless road shocks, engine vibration, and stresses of so much travel . . . and still be good for more. As for *performance,* these mounts were originally specified for the well known buses they're in because of *outstanding* vibration isolation.

It's all due to their design . . . the original "Isomode" principle developed by MB over 10 years ago. Cores are in *balanced* compression and shear . . . for the same spring rate in all planes. This controls all modes of motion with equal efficiency, permits mounting at any angle. Note, too, that this design is self-snubbing, preventing excessive motion and damage.

These special-performance, type 5 Isomode units are available as standard parts, with or without mounting ears, for loads of 50 to 2500 pounds. They can also be adapted to your specific needs.

Satisfying difficult vibration control requirements has been MB's business for 17 years. You're welcome to draw on this experience.

Bulletin 616 gives useful data. Send for your copy.

manufacturing company
A Division of Textron Inc.
1060 State Street
New Haven 11, Conn.

HEADQUARTERS FOR PRODUCTS TO ISOLATE VIBRATION . . . TO EXCITE IT . . . TO MEASURE IT.

FACT: New floating roll-table drive solves space, shock, maintenance problems

Basic facts show how Westinghouse floating gearmotors bring greater efficiency and economy to roll-type conveyor operations:

FACT 1: Space needs minimized by compact drive design
Shaft suspension of drive and absence of separate coupling give maximum spacesaving and assure greater operating safety.

FACT 2: Roll shocks cushioned by spring mounting
Spring mechanism on anchor arm and "on-shaft" mounting enable this gearmotor to withstand shocks and stresses from roll eccentricity.

FACT 3: Maintenance reduced by drive simplicity
Absence of couplings, simple yet rugged gear arrangement and integral design of over-all unit all combine to cut maintenance needs to the minimum.

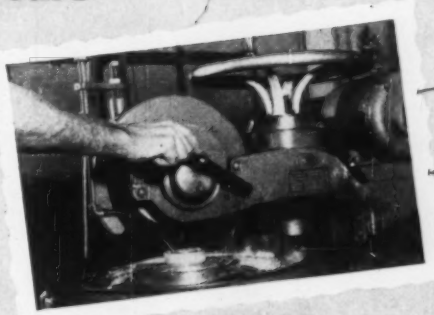
For more facts on this or any Westinghouse gearing equipment, call *The Man With The Facts*... he's the Westinghouse sales engineer at your nearest Westinghouse sales office! J-07343

A locking screw and clamping plate lock this compact gearmotor firmly to roll-table shaft. All power is transferred to roll shaft at low unit pressures.

WATCH WESTINGHOUSE!

*WHERE **BIG** THINGS ARE HAPPENING **TODAY!***

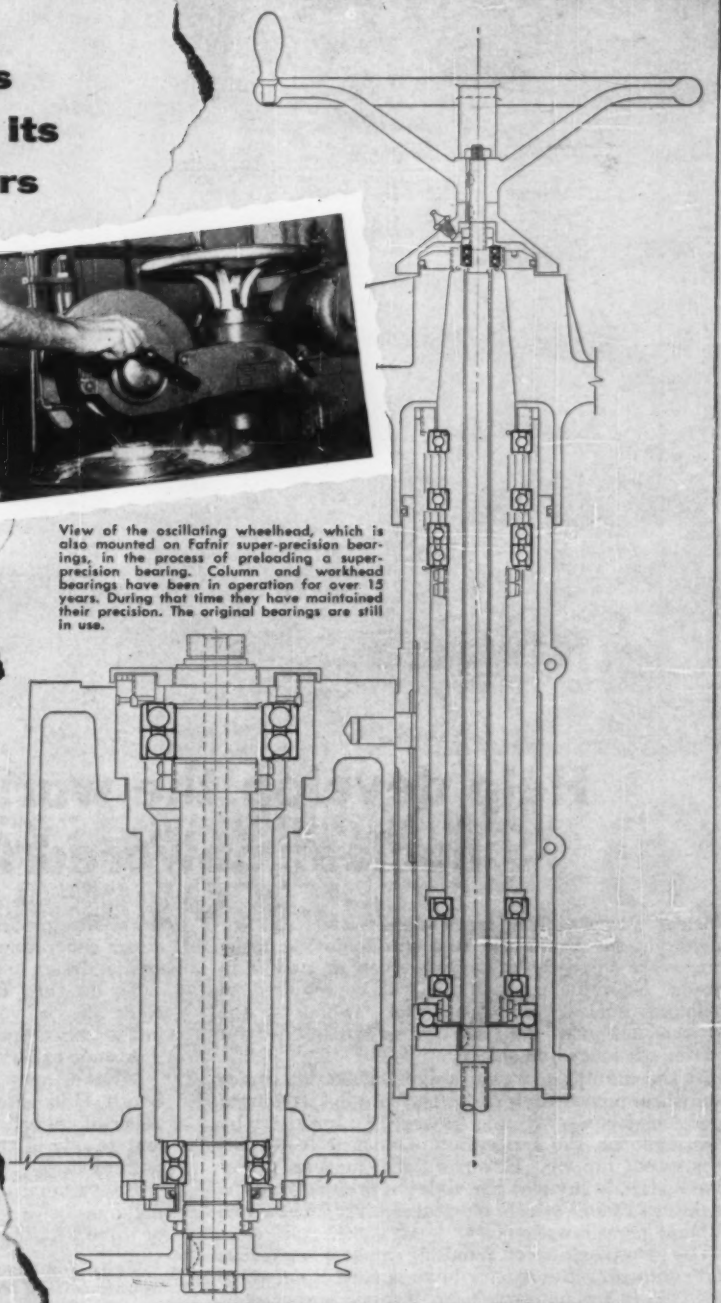
How a precision surface grinder is designed to hold its precision for years



View of the oscillating wheelhead, which is also mounted on Fafnir super-precision bearings, in the process of preloading a super-precision bearing. Column and workhead bearings have been in operation for over 15 years. During that time they have maintained their precision. The original bearings are still in use.

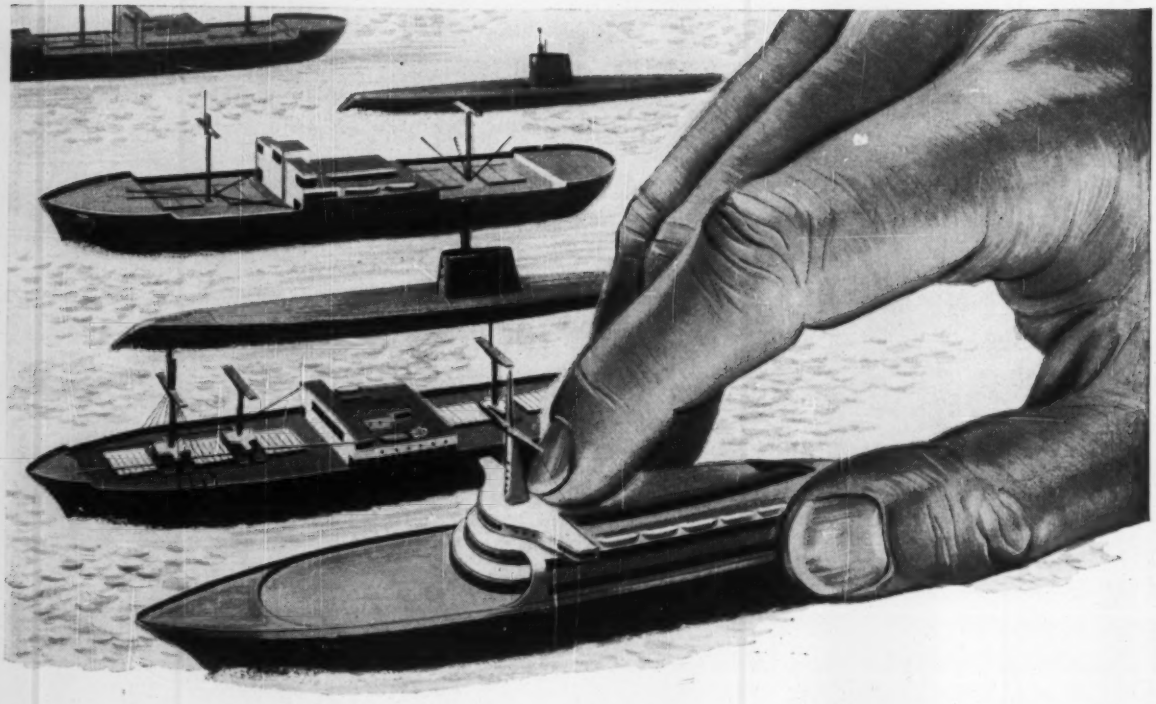
The job of preloading super-precision ball bearings calls for grinding precise amounts of stock from the faces of bearing rings. To obtain such results with a satisfactory degree of efficiency requires a grinder designed to maintain maximum rigidity and precise swiveling of its wheelhead arm plus precise rotation of its work spindle.

The diagram at the right shows how such rigidity is built into a precision surface grinder. All bearings indicated except the thrust bearing at the bottom of the column which supports the wheelhead arm are Fafnir super-precision, preloaded types. The use of these Fafnir ball bearings has resulted not only in work of dependable accuracy and finish, but also longer machine life. For other application data on Fafnir super-precision bearings plus dimensional and load rating details, write for Fafnir Precision Ball Bearing Catalog. The Fafnir Bearing Co., New Britain, Conn.



FAFNIR
BALL BEARINGS
MOST COMPLETE LINE IN AMERICA

ENGINEERS...



Help develop the world's first nuclear powered fleet

Nuclear power offers tremendous advantage for naval vessels. From the fuel standpoint, cruising ranges are virtually unlimited—even at new high speeds. No refueling facilities will be required to replenish nuclear propulsion fuel. Therefore, the physical design of the fleet can be streamlined for greater efficiency and safety.

At the country's largest design-engineering center for nuclear power reactors, Bettis Plant in Pittsburgh, operated for the Atomic Energy Commission by Westinghouse, the application of nuclear power has progressed rapidly. However, the nuclear power plants already in operation today represent only the beginning of a new technological era. *Major advances in many areas are necessary.*

The complexities of handling nuclear materials and controlling the reactor have opened up a whole new field in mechanism design. Atomic power plant equipment requires engineers who are capable of developing the unique valves and pumps that are required in the primary system of a pressurized water reactor. In addition, boilers, heat exchangers, steam generators and other plant equipment require special design and development work.

To do this, Bettis Plant needs farsighted men. Regardless of your interest, you can choose a place in the varied operations at Bettis Plant.

Atomic experience is not necessary.

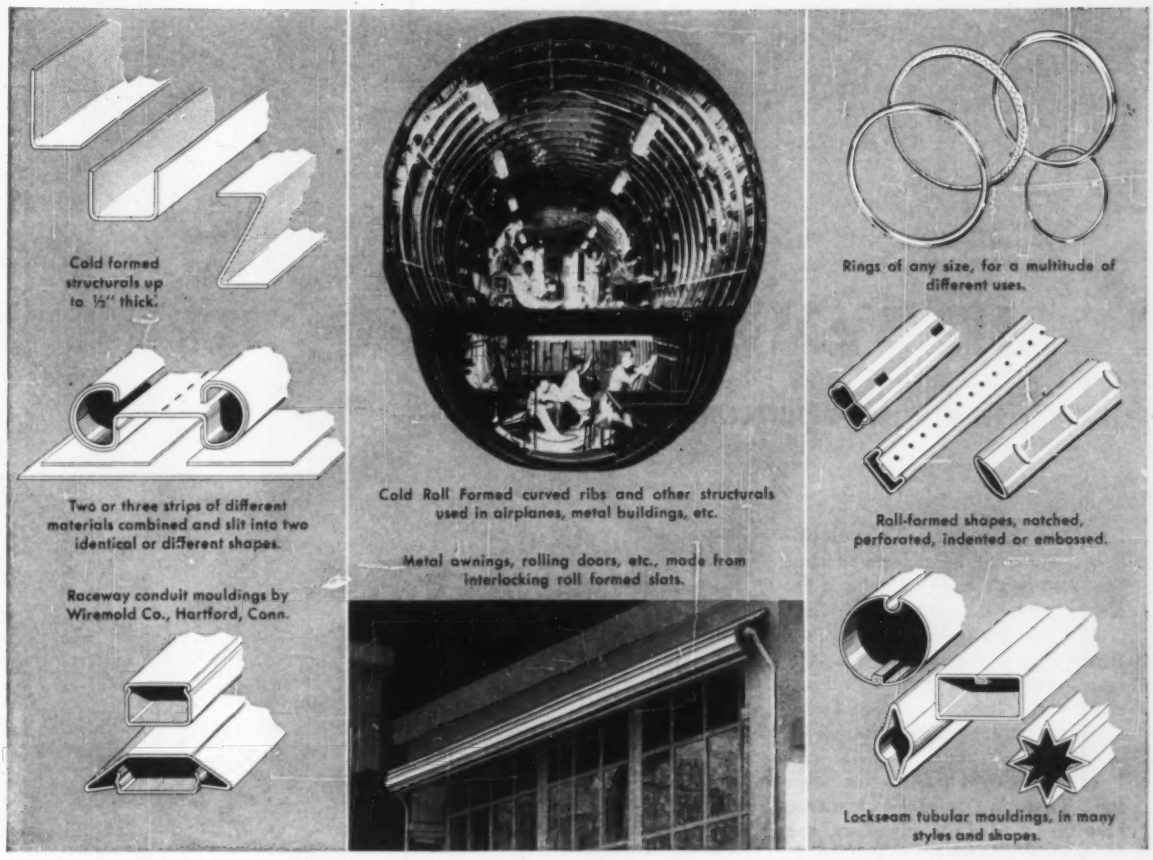
What's more, Bettis Plant is in Pittsburgh's South Hills. Here you can enjoy good living in pleasant suburbs near the plant, and still be convenient to one of the nation's most progressive metropolitan areas.

Educational opportunities are exceptional. Westinghouse helps you continue your studies at any one of three Pittsburgh universities.

Write for descriptive brochure on opportunities in your field. Be sure to specify your interests. Address Mr. A. M. Johnston, Westinghouse Bettis Plant, Dept. A91, P. O. Box 1468, Pittsburgh 30, Pa.

BETTIS PLANT

Westinghouse


Cold formed structurals up to ½" thick.
Two or three strips of different materials combined and slit into two identical or different shapes.
Raceway conduit mouldings by Wiremold Co., Hartford, Conn.
Cold Roll Formed curved ribs and other structurals used in airplanes, metal buildings, etc.
Metal awnings, rolling doors, etc., made from interlocking roll formed slats.
Rings of any size, for a multitude of different uses.
Roll-formed shapes, notched, perforated, indented or embossed.
Lockseam tubular mouldings, in many styles and shapes.

1001 Things Now Being Done By COLD ROLL FORMING

● The basic function of a Yoder cold roll forming machine is, of course, to convert flat rolled strip or sheets at high speed into mouldings, panels, tubular, channel and other shapes.

Quite often, these shapes need further elaboration before being ready for assembly or installation. They may, for instance, have to be curved, coiled or made into rings. Or they may need to be perforated at certain intervals of spacing, notched, embossed, or otherwise finished by additional operations. You may want to combine two or more materials into a finished shape, such as carbon steel with stainless, felt, wood, etc.

These and many other things can be done with Yoder machines at little or no extra cost over and above normal conversion costs, simply by providing special attachments, or by auxiliary units installed in line with the forming mill.

So, to the recognized high economy of the cold forming operation itself, other important production economies may be added. Yoder engineers are at your service in designing equipment of this kind.

The Yoder Book on Cold Roll Forming is a complete text, profusely illustrated, on the art and its scope, the machines, their tooling and application to a multiplicity of mass production needs. A copy is yours for the asking.

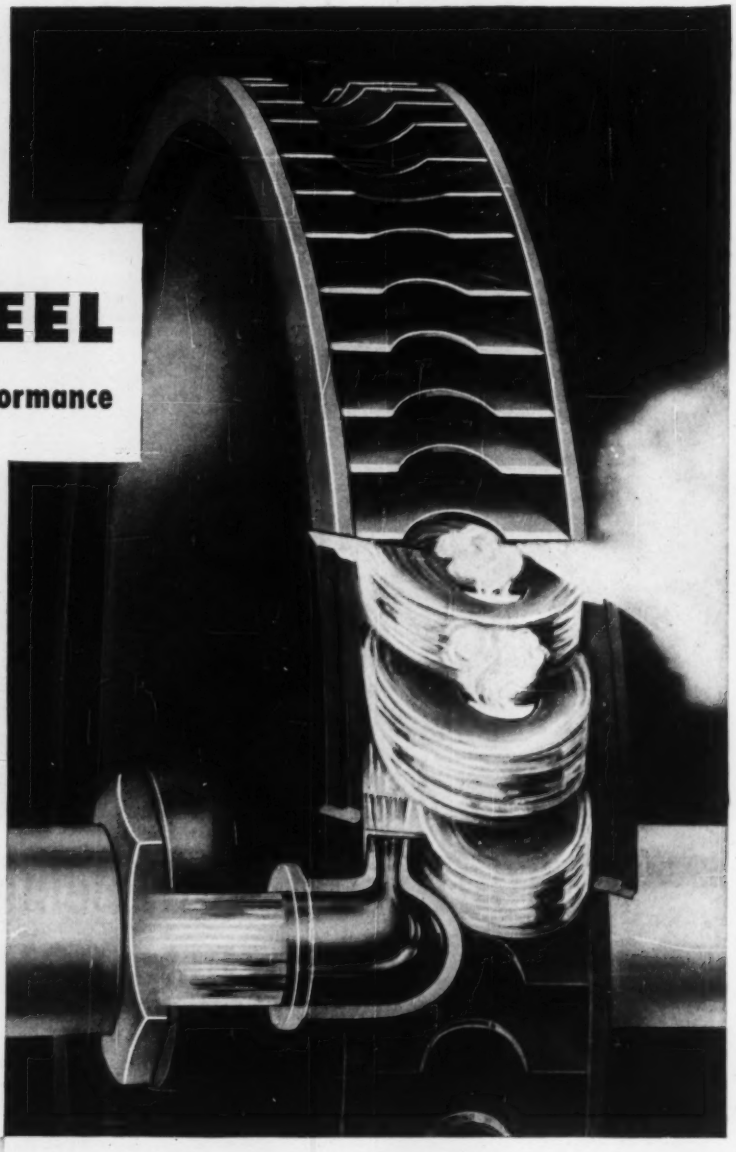
THE YODER COMPANY • 5499 Walworth Ave., Cleveland 2, Ohio

ENGINEERING YODER MANUFACTURING

COLD ROLL FORMING MACHINES
ROTARY SLITTING LINES
PIPE AND TUBE MILLS—Electric Weld

SOLID WHEEL

spells non-stop turbine performance



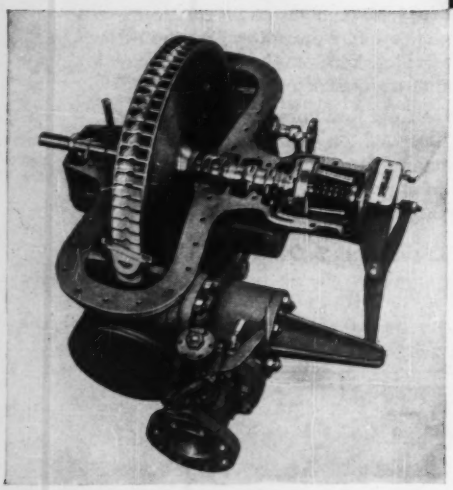
It's easy to see why Terry solid-wheel turbines have been setting non-stop records. They're built for long periods of continuous service.

The rotor, for example, is a single forging of special composition steel, in which a series of semi-circular buckets is milled. There are no separate parts to loosen or work out.

What's more, the blades can't foul. There is a one-inch clearance on either side of the wheel and the blades are double rim protected. There is no need for close axial blade clearance, because the steam enters the buckets at right angles to the shaft.

You, too, can profit from Terry solid-wheel stamina. Bulletin S-116 gives full details. Send for a copy today.

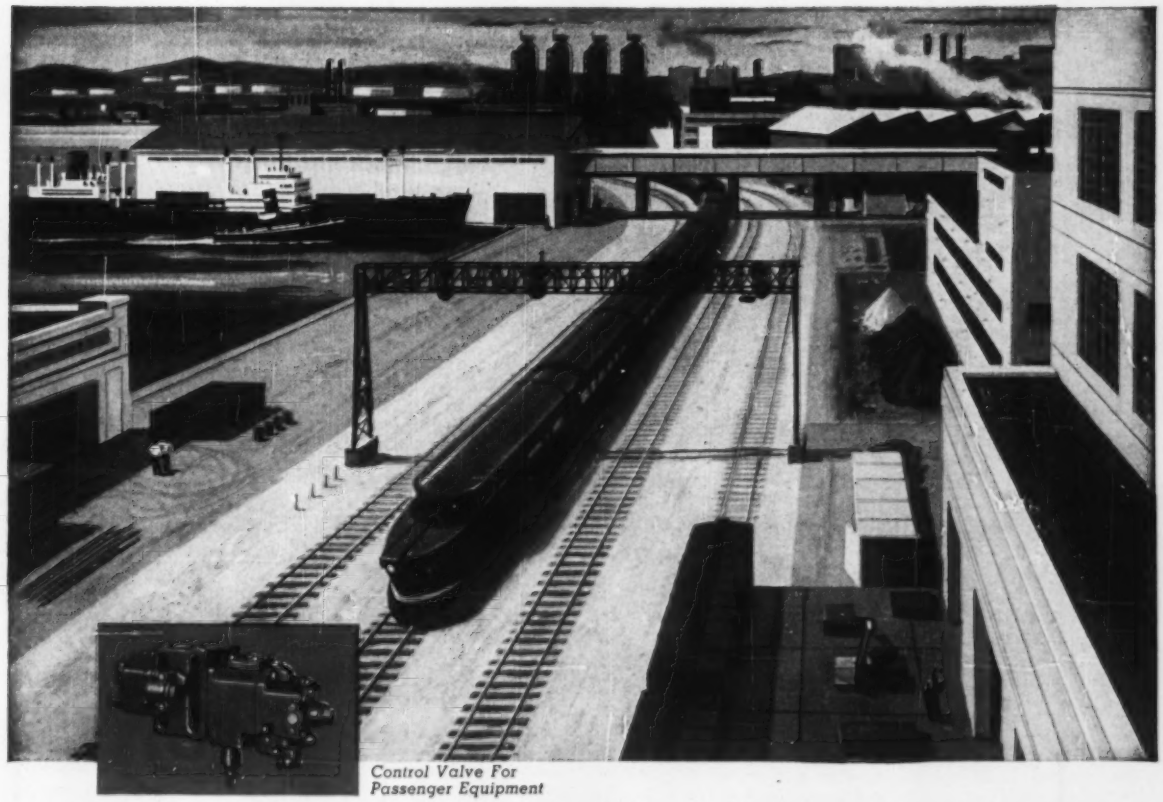
THE TERRY STEAM TURBINE CO.
Terry Square, Hartford 1, Conn.



Action of steam in a Terry solid-wheel turbine. The steam issues from an expanding nozzle at high velocity and enters the side of the wheel bucket where its direction is reversed 180°. As this single reversal uses but a portion of the available energy, the steam is caught in a stationary reversing chamber and returned again to the wheel. This process is repeated several times until practically all of the useful energy has been utilized.

TT-1205

TERRY



Control Valve For Passenger Equipment

Transportation Means Trains, Ships, Trucks, Planes and— ENGINEERING

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Watertown, N. Y.
Railroad air brake equipment of all types; STRATOPOWER Hydraulic Pumps for Aircraft, to 3000 psi.

KALAMAZOO DIVISION
Kalamazoo, Mich.
HYDRECO Gear-Type Hydraulic Pumps, 3 to 120 gpm; Fluid Motors, 3 to 52 hp; Cylinders; Control and Auxiliary Valves; 1500 psi. DUAL-VANE Hydraulic Pumps, 3 to 120 gpm; Fluid Motors, 7 to 140 hp; 2000 psi operation.

AURORA PUMP DIVISION
Aurora, Ill.
Liquid Handling Pumps, AURORA Centrifugals and deep well Turbines, 7000 gpm, 500 ft. heads. APCO Turbine-type 150 gpm, 600 ft. heads. Condensate Return Units.

KINNEY MANUFACTURING DIVISION
Boston, Mass.
KINNEY Vacuum Pumps, 0.2 micron, capacity to 5000 cfm; KINNEY Rotating Plunger and Helliquad Liquid Handling Pumps, to 3000 gpm.

VACUUM EQUIPMENT DIVISION
Philadelphia, Pa.
Complete KINNEY Vacuum Systems, Equipment and Components, Vacuum Research and Engineering

The ever-increasing demand for greater tonnage, higher speeds, finer appointments and assured safety for moving people and products brings into high focus the things that make such progress possible.

The modern freight train and tomorrow's sleek streamliners are advances in which the engineering of The New York Air Brake Company plays an important role. Precision engineering, plus craftsmanship, plus pneumatics "know-how" makes fingertip control for positive, velvet-smooth braking a reality on America's railroads.

For today's jet air liners The New York Air Brake Company builds STRATOPOWER Hydraulic Pumps. These Pumps have the watch-like precision to provide dependable Fluid Power for operating control surfaces and performing many other important functions on civilian and military aircraft, rockets and guided missiles.

Passenger ships, freighters and tankers, although larger and speedier than ships of yesteryear, load and discharge cargoes quicker and maneuver more alertly. DUAL-VANE and HYDRECO Fluid Power equipment brings simplicity, ease, speed and safety to steering, raising and lowering hatches, powering winches and cargo booms and other shipboard functions. Ashore, these same components operate lift trucks and conveyors. You'll also find AURORA and KINNEY Liquid Handling Pumps ... AURORA Pumps for fire fighting, boiler feed and water systems ... KINNEY Pumps for transfer of bunker fuel, asphalt, molasses, crude oil and gasoline.

KINNEY High Vacuum Pumps contribute much to modern transportation. High Vacuum technology is the magic ingredient in the manufacture of Radar, Electronic and Electrical devices, Refrigeration, Air Conditioning and the practical application of Atomic power.

Look to The New York Air Brake Company for progress and the engineering that serves both you and your products.

Write for full information on new developments in Hydraulic, Liquid Handling and Vacuum equipment.

THE NEW YORK AIR BRAKE COMPANY

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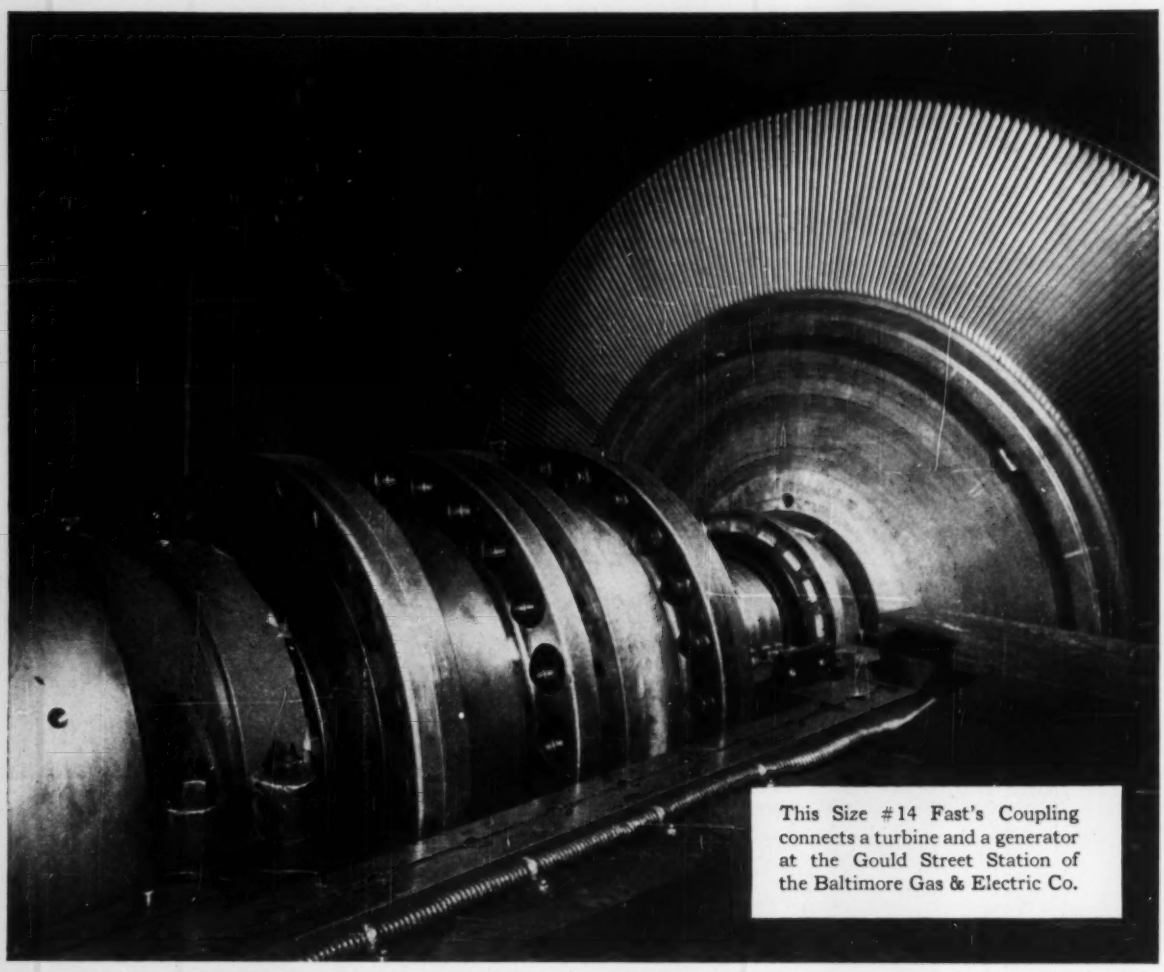
INTERNATIONAL SALES OFFICE, 90 WEST ST., NEW YORK 6, N. Y.



This Size #14 Fast's Coupling connects a turbine and a generator at the Gould Street Station of the Baltimore Gas & Electric Co.

This Fast's Coupling runs smooth after 29 years of service!

This Size #14 Fast's Coupling has never had a major part replaced since its installation on January 4, 1927.

The Baltimore Gas & Electric Company has provided excellent care and inspection . . . examining the coupling during each routine overhaul of the turbine and generator. The last inspection (shown above) was during the fall of 1955.

Unique design permits Fast's Couplings to compensate for both offset and angular misalignment of shafts and eliminates the wear of metal upon metal. It provides positive lubrication which forms a film on load-carrying surfaces of the teeth. Metal bearing rings located at the mid-axis of the teeth keep out dirt, grit and moisture—keep lubricant in. Fast's metal-to-metal seal protects the lubricant against pollution.

A Koppers engineer can show you how Fast's Couplings will give you extra years of service and reduce down-time. For more details, write to: KOPPERS COMPANY, INC., *Fast's Coupling Dept.*, 3412 Scott Street, Baltimore 3, Maryland.

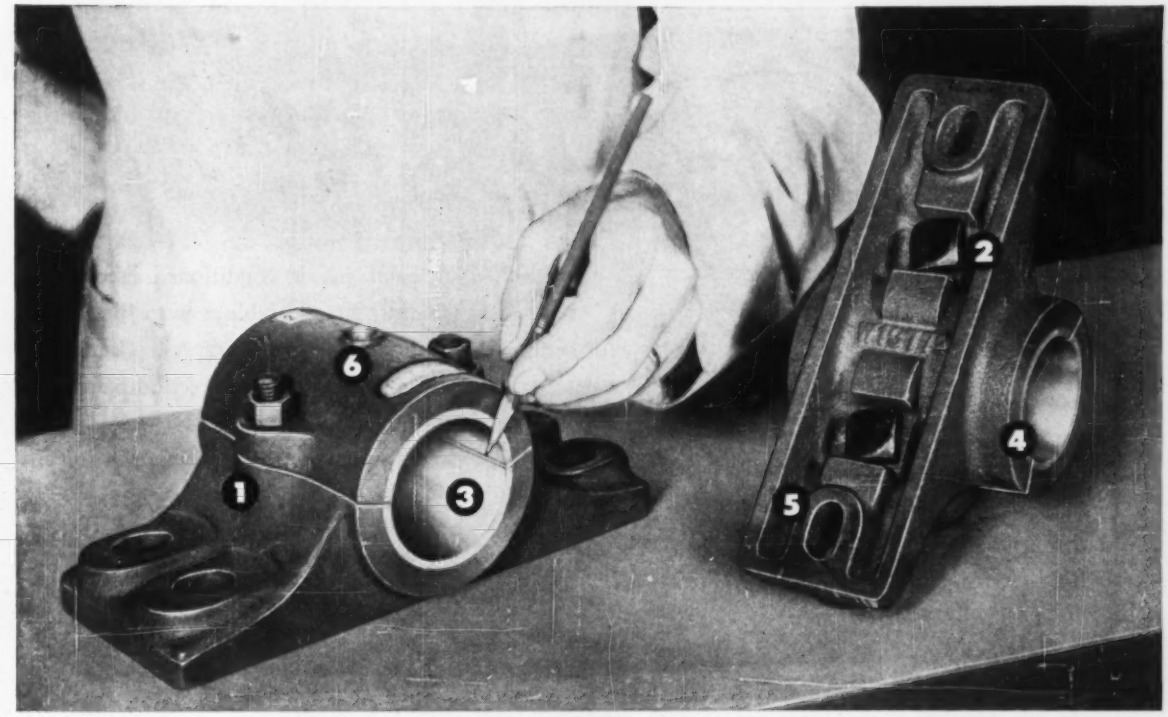
Koppers Company, Inc.
Metal Products Division
Baltimore 3, Maryland

Engineered **Products**
Sold With ***Service***

KOPPERS

THE ORIGINAL
FAST'S Couplings

Make this revealing
6-spot check
on babbitted and bronze bearing quality



LINK-BELT offers efficiency-proved features in a complete range of types and sizes

BEFORE you buy babbitted and bronze bearings, look for the features below. They're standard with Link-Belt—a complete range of more than 15 types and over 300 sizes of solid, split, gibbed or angle blocks. In addition, Link-Belt's broad distribution assures off-the-shelf delivery on sizes for ½- to 8-inch shafts, plus a wide variety of take-ups to meet any requirement. And for special applications, bearings can be furnished with cast steel housings.

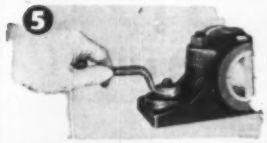
Each bearing incorporates a heavy-duty babbitt or high-quality bronze. Careful packing provides protection during shipment — decals identify each by serial number and size for re-ordering. See your nearest stock-carrying factory branch store or distributor.

HOUSINGS are of durable cast gray iron . . . compact, exceptionally strong and rigid. No excess weight.

BASES are finished for close tolerance from base to center of bore—assure firm seating on supports.

BORES are finish-machined to close tolerances . . . assure concentricity, accurate fit on the shaft.

ENDS are finished to provide accurate bearing surface for collar or sprocket . . . reduce friction.



BOLT HOLES in base are slotted for easy adjustments and accurate shaft alignment.

LUBRICATION of bearing is provided through grooves and fitting in cap.

LINK-BELT

BABBITTED AND BRONZE BEARINGS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 14,194

nuclear weapons development

SANDIA CORPORATION OFFERS OPPORTUNITIES FOR . . . *ENGINEERS, PHYSICISTS AND MATHEMATICIANS* IN THESE FIELDS

RESEARCH:
Studies of the reliability of systems components, nuclear weapons effects, aerodynamic characteristics, and quality expectation.

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Analysis of manufacturing and design procedures to determine and maintain proper standards.

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Determination and establishment of quality standards and enforcement of standards to assure quality of product.

Modern equipment in air conditioned laboratories, shops, and offices combines with liberal benefits, including free life insurance, sickness benefits, retirement and health protection plans, and extremely generous vacations and holidays to make Sandia an especially attractive place to work.

Albuquerque, with its exceptional climate and metropolitan blending of ancient and modern cultures, provides an informal, pressure-free environment for pleasant living. The city has an excellent school system. The University of New Mexico is also located here, providing opportunities for advanced study. Housing is readily available, and recreational facilities abound.

There are also openings for engineers and scientists in our expanding branch laboratory at Livermore, in the San Francisco area.

IF YOU'D LIKE MORE FACTS about Sandia Corporation, our background, our work, and the opportunities we offer, we'll be happy to send you our illustrated brochure which gives more details. Just write to Staff Employment Division 553A.

SANDIA CORPORATION

ALBUQUERQUE, NEW MEXICO

before after

Modern Dravo heating saves this plant $6732 per year, frees 3400 sq. ft. of floor space

Sharp increases in heating costs traveled hand-in-hand with growth and expansion at Ideal Electric and Manufacturing Company's Mansfield, Ohio plant.

As manufacturing additions went on over the years, more and more hand-fired coal stoves were employed to heat new areas. Until recently, heating for the seven-acre plant area was handled by thirty-two such units. Heating problems never seemed to cease. With the lack of uniformity in heating, workers either froze or baked. Coal and labor costs (it took almost the full time of 5 men to fire stoves around the clock) never stopped climbing. Stoves and their bins gobbled up more than 4000 square feet of plant space!

When modern Dravo gas-fired, forced-air space heaters were installed, these problems disappeared, and the savings were immediate and substantial. Since eleven Dravo "Counterflo" heaters provided comfortable heat everywhere in the plant areas, 3400 square feet of valuable space was released ("Counterflo" heaters required only 600 square feet). But, more important was the actual gross savings of $6732 made possible last winter, '54-'55, through the use of these Dravo Heaters. When amortizing this new and standby equipment over a 10 year period, a net savings of $2735 per year is realized!

Remarkable? Then you will want to see for yourself what unusual cost-savings and heating efficiency Dravo heaters can bring to your heating systems. Use the coupon below to get complete details. You'll find it always pays to investigate Dravo Heaters!

Dravo Corporation, Department A-1212
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Pittsburgh 22, Pa.

I am interested in Dravo Heaters for _____

☐ Please send literature
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VIBRATION MEASUREMENTS*

*(or stress, strain, force, torque, other mechanical or electrical variables)

BRUSH INSTRUMENTS RECORD THE FACTS YOU NEED AT ONCE

Brush's complete line of portable recording systems includes these portable amplifiers, and 1, 2, 4, and 6 channel oscillographs.

• You can quickly and easily record vibration data, using any commercially available vibration pickup, with appropriate Brush amplifiers and oscillographs. You can record 1, 2, 4, or 6 channels of data simultaneously.

Brush offers *complete* recording systems; for portable use, or for rack or console mounting. An electrically controlled chart drive permits selection of the chart speed best suited to the specific measurement—also provides instantaneous switching and remote control.

Get the facts from your Brush representative. Or write for bulletin to Brush Electronics Company, Dept. P-12, 3405 Perkins Avenue, Cleveland 14, Ohio.

BRUSH ELECTRONICS COMPANY
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BRUSH ELECTRONICS
DIVISION OF CLEVITE CORPORATION

*Wholly owned subsidiary of South Carolina Electric & Gas Co.

REPUBLIC *Automatic* COMBUSTION CONTROLS *Anticipate* FUEL-AIR-WATER REQUIREMENTS!

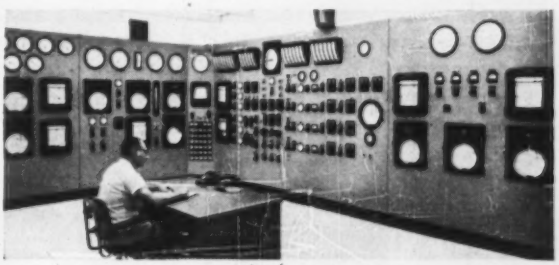
● Adjusts fuel, air and water as steam flow changes ● Makes follow-up adjustment of header pressure and water level if needed ● Prevents (rather than corrects) most pressure, level and temperature fluctuations before they happen!

Planned expansion of power in the Southeastern United States is typified by the addition of Unit #3 to South Carolina Generating Co.'s Urquhart Station. Rated capacity of the steam generator is 700,000 lb/hr at 1825 psi, superheated to 1010 F and reheated to 1010 F. Designed by Gilbert Associates, Urquhart #3 is modern in performance as well as appearance.

REPUBLIC's "Electronic Master" combustion control and triple-element feedwater control permit firing of pulverized coal, natural gas, or both at once without fluctuation of header pressure or water level. This system starts adjusting fuel, air and water as soon as steam flow changes perceptibly, not waiting for either drum level or header pressure to change.

If either of these factors change despite the preliminary adjustment, the change will be very small and will be offset immediately by a follow-up control that modulates the existing control signal. Since the flow of flue gas is held in such close proportion to the steam flow, temperature at the superheater outlet is held very close to a constant 1010 F despite load swings.

This advanced control system is a logical partner to the advanced thinking apparent throughout Urquhart #3. The quick action of electronic control added to the traditional reliability and power of pneumatic actuation produces a stable, accurate, dependable automatic system. And any one or all of the automatic control functions can be cut out at will to permit substitution of remote manual control at any time. Manual controls include indicators for electronic loadings of the regulators and positioners as well as position and rate of response indicators.



Control room of Urquhart Station's modern Unit #3.

NEED HELP on "Early Stage" Planning?

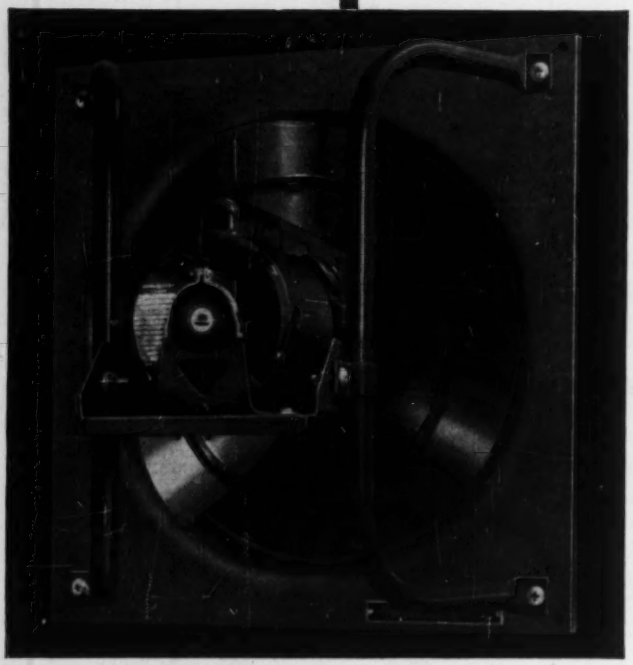
Remember that Republic, too, is planning ahead. To get the latest information on developments that will effect control in your future power or processing plant, contact the REPUBLIC Engineering Department as soon as such help would be beneficial.

REPUBLIC FLOW METERS COMPANY

2240 Diversey Parkway, Chicago 47, Illinois

American Blower
Ventura Fans
offer you

top performance and economical ventilation

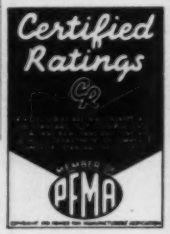


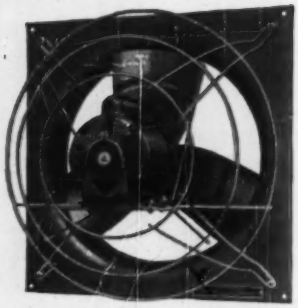
American Blower Model K Ventura Fan

You can count on American Blower Ventura Fans to do the job they are designed for, with high efficiency and a minimum of maintenance. They are built for long life and top performance. All ratings are certified.

American Blower Model K Ventura Fans are ruggedly constructed, heavy-duty propeller fans for tough industrial applications. They offer the power you need . . . when you need it, and will operate against static pressures up to 5/8". Request Bulletin 6514.

American Blower Ventura Fans are attractively designed, quality built, and easy to install . . . *yet competitively priced*. Ventura Fans come in a wide range of sizes and capacities — with constant-speed and two-speed direct drives, totally enclosed motors — to satisfy your exact requirements.





Model G Ventura Fans

Model G, at left, is a sturdily built and attractive fan suitable for light industrial duty and commercial applications. It is especially quiet-operating, making it ideal for offices, stores, and lobbies — or wherever quiet operation is required. Write for your copy of Bulletin 6414, which gives complete performance data.

American Blower products serve industry

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Gyrol Fluid Drives
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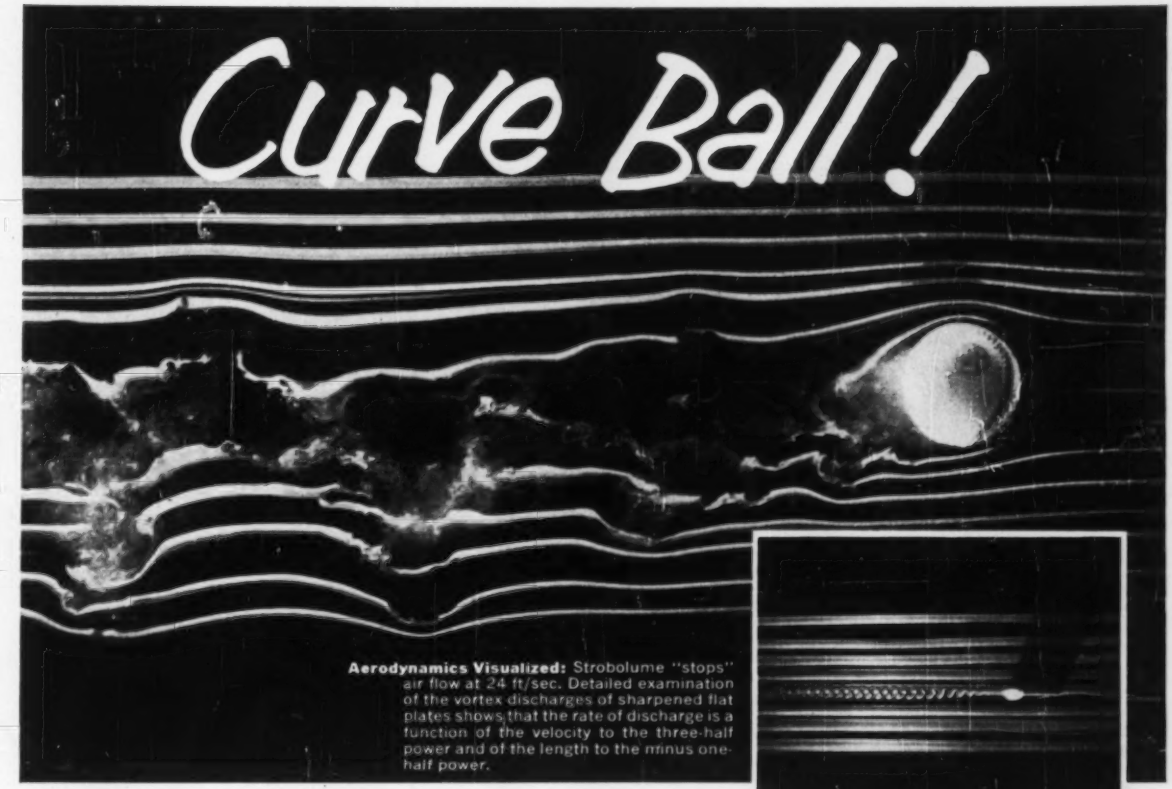
AMERICAN BLOWER

Curve Ball!



Aerodynamics Visualized: Strobolume "stops" air flow at 24 ft/sec. Detailed examination of the vortex discharges of sharpened flat plates shows that the rate of discharge is a function of the velocity to the three-half power and of the length to the minus one-half power.

Short Duration Flash: 10 millionths of a second at low-intensity position; 30 millionths at high intensity.

Light Intensity: eight million beam candles, 400 times that of ordinary stroboscope.

Speed Range: up to 3000 flashes per minute; 1200 per minute, maximum, on high-intensity flash.

Ease of Operation: light source is simply aimed at subject; because there is no physical connection between stroboscope and object under study, there can be no instrument effect on operation.

Removal Lamp Housing: lamp may be used at end of 14-foot cable to reach otherwise inaccessible places.

Versatility: can be synchronized with any simple make-break device, or controlled by G-R Type 631-BL Strobotac or Type 1535-B Contactor; push button provided for manual flashing.

Compactness: 7½" x 13" x 11"; 18½ lbs. over-all; lamp assembly only 2 lbs.

Type 1532-B Strobolume $275.

What effect do the seams of a baseball have on its wake and on its path of travel? The answer: wake effects are very small — and, seams actually improve path stability, aiding the pitcher's control. To determine this, Professor F. N. M. Brown, of the University of Notre Dame, photographed first a speeding baseball and then a perfectly smooth sphere with the aid of high-intensity, short-duration light flashes produced by General Radio stroboscopic equipment.

The ball was photographed in a small wind tunnel filled with smoke streamers to make the air flow visible. Photographs were taken with a standard Graphic View camera which was synchronized with three G-R Strobolumes to provide an intense white light with exposure time of 20 microseconds.

Studies conducted with the "visualization" technique described here have established many aerodynamic facts. (See inset photograph above.) The Strobolume's ability to "stop" rapidly moving objects has proven of great value to researchers such as Professor Brown. Others, engaged in a variety of development and research programs, have benefited as well.

For the designer or engineer, stroboscopic light is a tool which permits detailed visual examination of rapidly moving mechanical parts and cyclic operations with a *convenience*, *rapidity* and *effectiveness* not otherwise available.

Write For Complete Specifications and Details Concerning G-R's Complete Line Of Stroboscopic Instruments.

STROBOLUME

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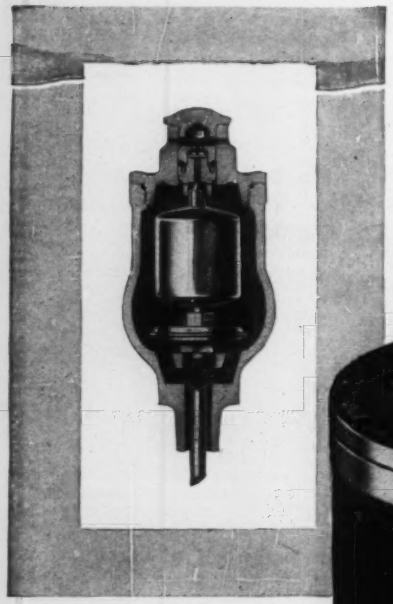
WE SELL DIRECT, Prices are Net, FOB Cambridge or West Concord, Massachusetts



A well placed air vent can work a heating miracle!

No. 5 Rapid Vent. Float and thermostatic construction. Designed for use at the end of steam mains, tops of risers and other similar locations on vapor and one pipe vacuum systems where the maximum venting requirement does not exceed one cubic foot per minute at 5 psi.

No. 6 Quick Vent. Thermostatic only. Designed for installation at high points in the piping where there is not sufficient room for the No. 5 Vent or where a float is not needed. Same venting capacity as No. 5.

In a Wilmette Illinois Building, an outwardly well-engineered vacuum system had been a headache for years. Then, last winter, along came a heating man who quickly sized up the situation and said with real conviction: "Put a Marsh No. 5 Vent right there!"

That did it! One inexpensive vent cleaned up a spotty, erratic condition, that a number of expensive alterations had failed to touch.

Unusual? Not in the least: over the years we have seen a lot of wonders worked by installing the right kind of Marsh air vent in the right spot. A number of these dependable vents are illustrated here . . . products that express an unrivaled accumulation of knowledge in dealing with air venting problems.

Marsh air vents are fully covered by the Marsh Heating Specialty Catalog along with Marsh Traps and Valves. Your local Marsh man will be glad to work with you in applying Marsh Vents effectively.

No. 50 Air Vent. Float only. Designed to remove air and gases automatically from hot or cold water tanks, coils or piping, liquid pump systems or similar applications where it is necessary to vent air rapidly. Maximum working pressure, 125 psi.

No. 55 Air Vent. Float and thermostatic construction. Is capable of expelling large volumes of air without passage of water or steam and is designed for use on steam pressure vessels or systems. Maximum working pressure, 125 psi.

No. 7 Air Eliminator. Float and thermostatic construction. Expecially suitable for installation at the ends of steam mains, return piping and tops of risers where it is necessary to expel a large volume of air from the system. Suitable for working pressures up to 15 psi.

MARSH HEATING EQUIPMENT CO.

Sales Affilate of Jas. P. Marsh Corporation

Dept. 29, Skokie, Ill.

MARSH

Quality Heating Specialties since 1865

For faster flow and freedom from plugging

filter fluids with American Felt!

The very construction and character of wool felt make it a natural for filtering liquids. The unique, fibrous structure of wool felt has these outstanding advantages: 1—Efficient particle retention. 2—Minimum pressure drop with corresponding high permeability. 3—Maximum solids capacity resulting in greater liquid throughput. 4—High porosity value responsible for low plugging rate and ease in cleaning. 5—Chemical and thermal stability. 6—Felt's thickness permits free use of third dimension in design and in true edgewise flow.

American's Wool Felts for liquid filtration provide efficient and economical filter media for cellulose nitrate, solvents, hot lubricating oil, paint, lacquer, latex, water, food syrups, and oils. Their outstanding characteristics give them great versatility in method of use because of the high degree of porosity and the many types of felt constructions available.

For complete details write, on your company letterhead, for FREE, 10-Page Data Sheet No. 17 on "Wool Felt-Liquid Filtration". And remember: American Felt Company also produces engineered Synthetic Fiber Filter Felts.

Directly above is a microscopic (175x) view of wool felt demonstrating the filtration mechanism attributed to the Van der Wall Forces. Note how solids smaller than pore size (in red) are held on the fiber by molecular attraction; with minimum flow resistance and freedom from plugging. **SEND TODAY for this FREE, 10-Page Data Sheet No. 17. Please make request on company letterhead.**

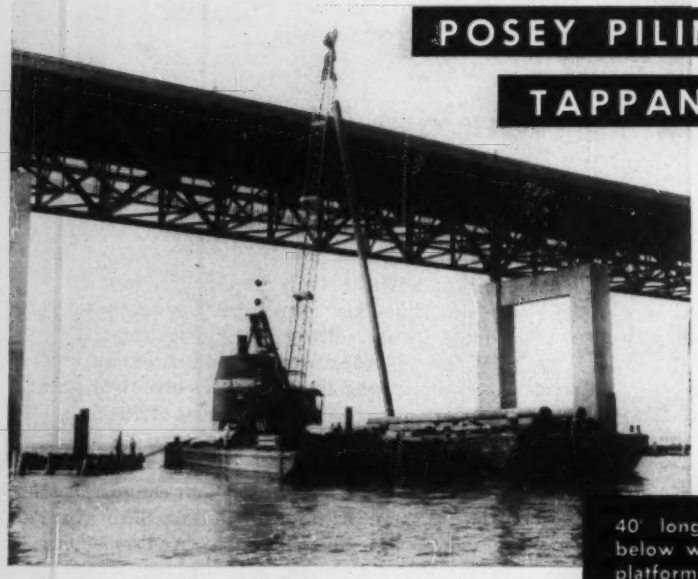
American Felt Company

TRADE MARK

GENERAL OFFICES: 50 GLENVILLE ROAD, GLENVILLE, CONN.

SALES OFFICES: New York, Boston, Chicago, Detroit, Cleveland, Rochester, Philadelphia, St. Louis, Atlanta, Greenville, S.C., Dallas, San Francisco, Los Angeles, Portland, San Diego, Seattle, Montreal.—PLANTS: Glenville, Conn.; Franklin, Mass.; Newburgh, N. Y.; Detroit, Mich.; Westerly, R. I.—ENGINEERING & RESEARCH LABORATORIES: Glenville, Conn.

POSEY PILINGS HELP PROTECT TAPPAN ZEE BRIDGE PIERS

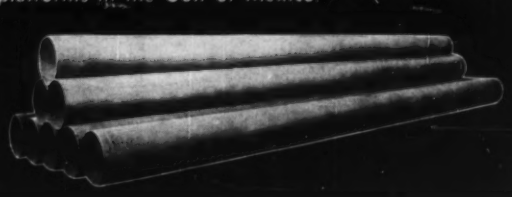


Posey Pilings . . . 52′ long, 30″ O.D., ½″ wall . . . have been driven deep into the bed of the Hudson River to protect the piers of the New York Thruway Tappan Zee Bridge from the destructive pounding of floating ice and debris.

Posey is equipped to meet your requirements in pipe and piling from 20″ diameter and larger. Budget and delivery agreements rigidly observed. Write for prices and specifications without obligation.

Fabricated in accordance with ASTM Specifications A-252, Grade 2

40′ long, 30″ O.D. ½″ wall Posey Piling below was fabricated for off-shore oil well drilling platforms in the Gulf of Mexico.



POSEY IRON WORKS, INC.

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New York Office: Graybar Building

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Opportunity to work with experienced cryogenic engineers on the ballistic missile program and major industrial problems.

ADL is pioneering in the field of gas liquefaction, handling and storage at temperatures to minus 450°F. Process development includes the stress analysis and design of specialized light-weight structures, the design of pumping and piping systems to handle extremely cold liquids, the perfection of insulation systems, and related technical research.

Assignments are varied and call for marked ability in problem solving. Other requirements include:

- **Degree in Mechanical or Chemical Engineering**
- **3 or more years' industrial experience with emphasis on process design and development. Experience in heat transfer and fluid flow desirable.**
- **Desire to be associated with a growing industrial research organization of top-flight scientists and engineers.**

Please submit resume and salary requirement to Personnel Director

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30 Memorial Drive

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Seventy Years of Research for Industry

MECHANICAL ENGINEERING
November, 1956 CARD INDEX Vol. 78, No. 11

How to Analyze the Cost of Machine Tools—
From the Swivel Chair, Realf Ottesen 1002
Propulsion Wind Tunnel at NACA Lewis Laboratory, E. W. Wasielewski 1007
Alignment Diagrams From Network Charts by Graphics, D. P. Adams 1013
Polyurethane Rubber as a Material of Construction, G. H. Gates and W. M. Larson 1016
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For Reference

A 20-PAGE LIST OF ASME PUBLICATIONS

is included in the

1957 MECHANICAL CATALOG

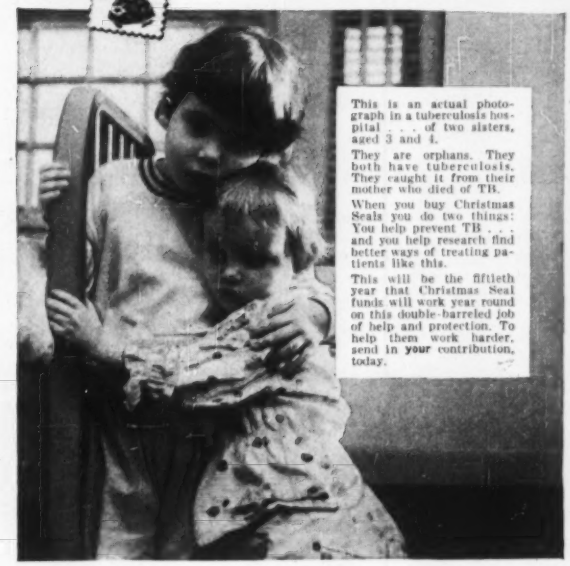
Copies of the List are obtainable from

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Publication-Sales Dept.

29 West 39th St., New York 18, N. Y.

What Do You Do When You Buy Christmas Seals



This is an actual photograph in a tuberculosis hospital . . . of two sisters, aged 3 and 4.

They are orphans. They both have tuberculosis. They caught it from their mother who died of TB.

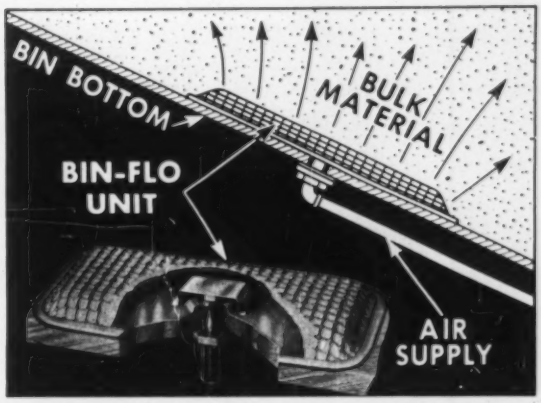
When you buy Christmas Seals you do two things: You help prevent TB . . . and you help research find better ways of treating patients like this.

This will be the fiftieth year that Christmas Seal funds will work year round on this double-barreled job of help and protection. To help them work harder, send in **your** contribution, today.

50TH Annual Christmas Seal Sale

Because of the importance of the above message, this space has been contributed by

MECHANICAL ENGINEERING



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USES SMALL VOLUME OF AIR AT LOW PRESSURE

KEEPS BULK MATERIALS MOVING

BIN-FLO units in bins, chutes, hoppers, etc., restore flow characteristics to dry, finely ground materials which tend to pack or bridge in storage. Types for all materials and conditions. No moving parts; simple installation; negligible operating cost; no maintenance cost.

BIN-DICATOR bin level indicator—"The Eyes of the Bin"—automatically reports levels of materials in storage; automatically controls filling machines; prevents waste.

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GET GOOD DESIGN, GOOD LOOKS, HIGH QUALITY AND QUICK AVAILABILITY FROM PEERLESS PUMPS

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Please send Bulletin No. 8-2300 describing economical Fluidyne pumps.

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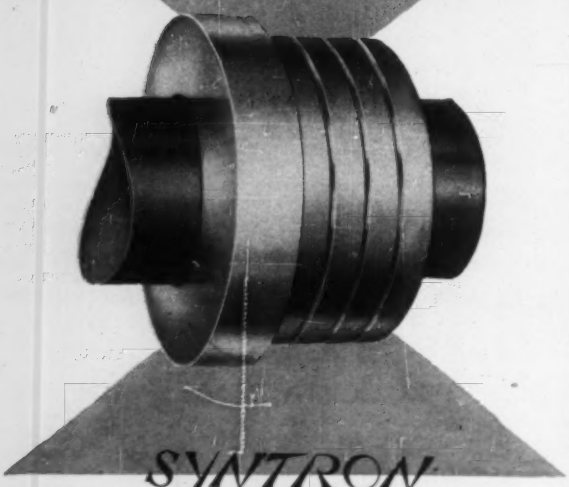
Right for the job!



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SHAFT SEALS
REDUCE MAINTENANCE COSTS

Stuffing box packing and repairing seem relatively simple,—a few minutes here, and a few minutes there—month after month. If your operation is typical—keeping a constant check on shaft seals and yet never really being able to stop troublesome leakage, soon adds up to a lot of man hours.

Syntron offers Quality and Dependability. Syntron Mechanical Shaft Seals provide positive sealing of gases and liquids around rotating shafts. Syntron Seals will outlast ordinary stuffing box packing many times.

Other Syntron Equipment of proven dependable Quality

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Reduce space and initial cost and still meet the requirements of your a-c to d-c conversion. Longer life—Largest range of sizes in the industry.

VIBRATORY FEEDERS

Feed bulk materials at controlled rates from a few pounds to hundreds of tons per hour. Fine powder of lumps—dry or damp.

INFRARED HEATING PANELS

Heat by direct radiation—not by reflection. Radiates even heat pattern with no blind spots.

Write for complete catalog—Free

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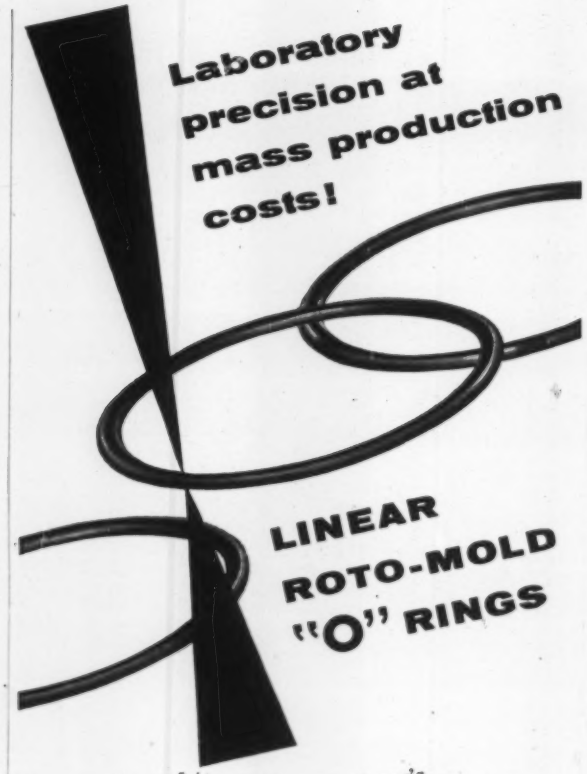

LINEAR ROTO-MOLD "O" RINGS

Do you have the facts on Linear's new, exclusive ROTO-MOLD process? It brings *automation* to the packing industry—makes possible fast delivery of perfectly uniform "O" Rings in any quantity!

★ Linear ROTO-MOLD "O" Rings are made with laboratory precision in single cavity molds under individually controlled pressure. Molding dies are automatically brought into microscopic alignment.

★ Every ROTO-MOLD "O" Ring is perfectly circular in cross section, with no transverse or other seams. You get precise uniformity without trimming or grinding.

Linear ROTO-MOLD "O" Rings are available now, in a variety of sizes and compounds, to meet your exacting requirements. Write, phone or wire for complete details.

"PERFECTLY ENGINEERED PACKINGS"

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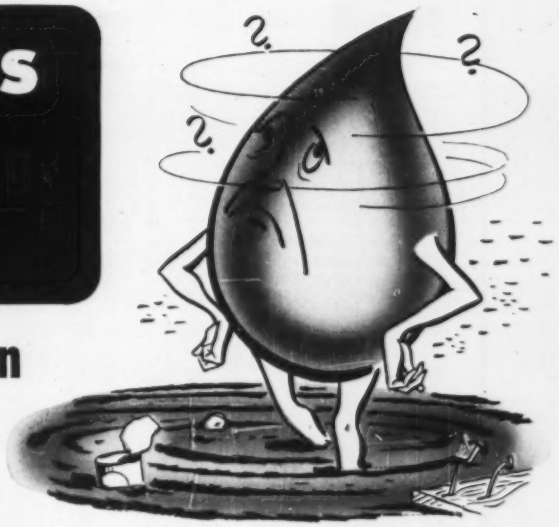
ALLIS-CHALMERS

ON THE JOB



Reporter finds solution to wide range of water problems

•Raw water is seldom suitable to meet specific requirements of the job. It usually needs some type of conditioning — best determined by a specialist. Here are typical examples of Allis-Chalmers water conditioning experience, equipment and chemicals in use.

Saved $22,000 First Year

Kansas—A chemical company plagued by high steam costs. Their boiler make-up water contained a high solids concentration, requiring a high blowdown rate.

After careful analysis of their problems, an Allis-Chalmers water conditioning engineer recommended Allis-Chalmers Anti-Foam. Use of this chemical resulted in increasing the solids concentration of the boiler water without carry-over. This, in turn, reduced the percentage of blowdown required.

Using A-C Anti-Foam, the company conservatively estimated first year savings of $22,000 in heat, water and chemicals.

* * *

Replacement of Condensate Return Lines Reduced to Practically Zero

Wisconsin—Here in one of the largest malt producing mills, several million pounds of steam are used daily for drying malt.

A special crew used to work all day every day doing nothing but replacing corroded condensate return lines. This, of course, was extremely costly.

Seven years ago, Allis-Chalmers water conditioning engineers were called in. Use of Allis-Chalmers No. 160 return line corrosion inhibitor was suggested.

Piping failures were reduced to the point where they only occur occasionally, and the maintenance crew has been assigned to other duties.

The Customer Is Always Right . . . Well, Most of the Time

East Coast — This plant had been using internal treatment of its boiler water. Chemical costs seemed excessive to management. After analyzing their own situation, they requested bids on a deionizer for treating makeup.

Instead of merely submitting a bid on the equipment specified, Allis-Chalmers engineers analyzed the water and the plant problem. This analysis showed that plant needs were such that a de-ionizer wasn't needed.

All that was needed was a de-alkalizer. Result: a savings of thousands of dollars.

* * *

The Case of the Dirty Dishes . . . or Don't Blame the Poor Dishwasher

Midwest — A harried plant cafeteria manager placed a frantic call to Allis-Chalmers water conditioning experts. Something was wrong. Glasses were spotty and plates had to be individually wiped off before they could be used. The grumbles were growing in the dining room . . . costs rising in the kitchen. His brand new $30,000 dishwasher wasn't getting the dishes clean, and the supplier of the dishwashing machine said the trouble was caused by the water.

The only trouble with that theory was that he had just installed a water softener the year before. The Allis-Chalmers water conditioning engineer examined the dishes coming out of the water and then asked to see the water softener. The problem was obviously hard water. The unit seemed to be in good working order and the tag indicated the softener had been recharged the previous day.

The maintenance man was called and asked to recharge the softener while an A-C engineer stood by. He went through all the steps—all but one, that is. He failed to close the bypass valve above the softener and practically none of the water went through the softener. It was then learned the operator was new and had not been properly trained.

Needless to say, the maintenance man is now an expert at operating the system, and everyone is pleased with the sparkling dishes.

Moral: A-C engineer's service covers the water front.

Expert Saves Steam for Drop Forge User

North Central — An Allis-Chalmers water conditioning engineer was called in by a manufacturer to supply water conditioning for makeup water. In checking the plant, here's what he found:

A large number of steam-operated drop forges are used by this company. The steam picked up oil from the pistons of the forge and was too contaminated for further use. It was dumped to waste.

He recommended installation of condensate oil removal filters. This was done and today practically all condensate is recovered. Makeup and water conditioning requirements are greatly reduced.

Problems Solved

For an answer to your industrial water problem, call the A-C office nearest you or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.

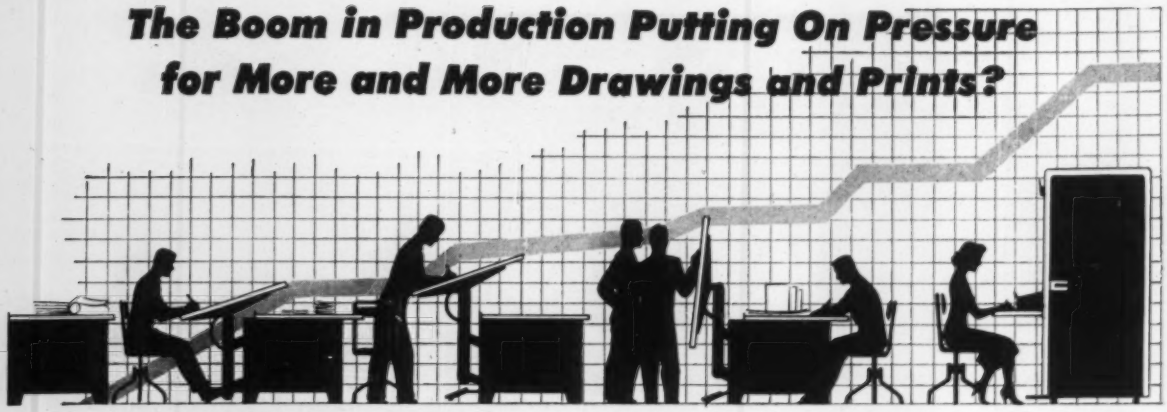
ALLIS-CHALMERS

WATER CONDITIONING • CHEMICALS, EQUIPMENT, SERVICE • FOR OVER 25 YEARS

A-C ALLIS-CHALMERS

A-5237

The Boom in Production Putting On Pressure for More and More Drawings and Prints?



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If your company, like most others, is gearing up for greater-than-ever production, it will mean more pressure on your drafting room for engineering drawings and prints. You couldn't pick a better time to get a new modern reproduction machine. And you couldn't make a wiser choice than efficient, trouble-free Copyflex.

In just the last year, Bruning has introduced five new advanced machine models, two of which are shown here. These machines cover the reproduction needs of engineering departments, from the smallest to the largest. They offer you the famous problem-free installation and operation of Copyflex . . . no exhaust venting, no plumbing or auxiliary equipment, no installation other than an electrical connection. They bring you faster reproduction and a host of operator conveniences that will help you boost drafting room output, keep costs at a minimum.

Now is the time to act. Mail the coupon below. You will be glad you did.

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Please send me information on Copyflex process and
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ANSWERS to box number advertisements should be addressed to given box number, care of "Mechanical Engineering," 29 West 39th St., New York 18, N. Y.

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1957
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Long established firm of consulting engineers with worldwide practice needs piping and air conditioning designers and draftsmen for work on hydro powerplants. Five years' experience preferred. Permanent positions. Liberal employee benefits. Starting salaries dependent on qualications. Please send complete resume to

Personnel Department
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AERO-THERMODYNAMIC DEVELOPMENT
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Qualifications include 2 to 6 years' experience in thermodynamics and aerodynamic development. Work involves thermodynamic and fluid flow aspects of turbine type aircraft engines and components.

Openings in the west and Mid-west

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For Positions In
NUCLEAR WEAPONS FIELD

Responsibilities include the analysis of data, assignment and interpretation of sampling plans, training, evaluation of inspection effectiveness and product quality. Applicants must have a degree in Mathematics, or in Mechanical or Electrical Engineering.

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MECHANICAL ENGINEER: To supervise activities of close-knit Engineering Design Group of a metallurgical and process research laboratory. Responsible for lay-out and design of metallurgical, metallurgical-chemical and chemical equipment, and small pilot plants as well as design work on an extensive variety of other projects. Advanced degree desirable and 3 to 5 years' experience in related work required. Send resume of education, experience and desired salary to:

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IN LIQUID NITROGEN

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- **application of liquid nitrogen temperature in the shipment of frozen foods without intransit refrigeration.**

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Bachelors or Masters are invited to investigate.

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Refer to ad: ME-N

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EBASCO
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The man who fills this position should have Ch.E., have done post graduate work in Business Administration, possess good judgment, drive and executive capacities. Salary commensurate with experience.

Send resume in full confidence to:

MR. W. W. PATTERSON, **Ebasco Building, 2 Rector Street, New York, N. Y.**

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OR EQUIVALENT IN EXPERIENCE

FOR REPUBLIC AVIATION

To conduct experimental processing in fabrication work on new metals as they enter the airframe fabrication field. Must be able to evaluate the applicability of existing methods, develop new techniques, write reports and prepare process control sheets. Must have broad knowledge of sheet metal processing and be capable of carrying on experiments with a minimum of close supervision. Experience in aircraft manufacturing fields is preferred. Among other advantages, Republic offers a comprehensive employee benefit program which includes company paid hospitalization insurance, surgical insurance, accident and life insurance, tuition (⅔), 2-fold pension plan, and individual merit rated increases, PLUS living on Long Island, playground of the East Coast.

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Excellent Opportunity *for* PLANT ENGINEER

Progressive, fast-growing regional brewery seeks plant engineer with good working knowledge of plant lay-out, materials handling, effective maintenance methods. Experience in refrigeration, electronic devices, hydraulics helpful. Will be department head responsible for activating, supervising plant-wide maintenance program. Should have minimum eight years' experience similar work. Excellent working conditions. Liberal employee benefits. Relocation expenses paid. Please write complete details of education and experience, including initial salary requirements. All replies confidential.

Address CA-6012, care of
MECHANICAL ENGINEERING

MECHANICAL ENGINEER

Graduate mechanical engineer in power plant design work. Experience not required. Excellent opportunity with consulting engineering firm in the Middle West. Liberal benefit plans and good working conditions.

Send resume of education and experience with statement of salary requirements.

Address CA-5905, % "Mechanical Engineering."

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Several graduate engineers with minimum 5 years' experience supervising maintenance engineering functions in oil refining or producing facilities, power plants, heavy industrial installations, manufacturing plants or related operations. To establish technical supervision, procedures, maintenance operations, and schedule routine and special work for major oil producing and refining operation with all supporting facilities; i.e., housing, feeding, recreation, etc.

Salary commensurate with background and experience. Write giving full particulars regarding personal history and work experience. Please include telephone number.

Recruiting Supervisor, Box 66

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You'll find professional stimulation in

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These RCA problems call for truly advanced effort. You will be challenged by the severe environmental conditions encountered in the supersonic flight of tomorrow's highest-speed aircraft. New concepts in mechanical design are required to deal with previously unexplored states of temperature, altitude, shock, vibration and humidity.

Plus . . . completely equipped engineering laboratories—advancement on merit—full benefits program—relocation expenses paid.

Please send resume of education and experience to:

Mr. John R. Weld, Employment Manager
Dept. V-3M, Radio Corporation of America
Camden 2, N. J.

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DEFENSE ELECTRONIC PRODUCTS

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Check This List of Professional Skills

- ☐ Aerodynamics
- ☐ Thermodynamics
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- ☐ Fluid Dynamics
- ☐ Heat Transfer
- ☐ Experimental Analysis

Experience in one or more of these fields may be *your passport* to *an unusual job.*

The positions we are talking about are with the Small Aircraft Engine Department of General Electric and involve complex theoretical and analytical work. Specific assignments involve developing components for new small turboshaft, turboprop and turbojet power plants for helicopters, convertiplanes, and other small aircraft. These components include:

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- nozzles
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These opportunities for advanced work can lead to positions on either the specialist or management side of engineering. The benefits are extensive, and the location—within ten miles of Boston—rates high in culture, education and recreation.

Write in complete confidence to:

Mr. T. S. Woerz (Section R-A-2)
Small Aircraft Engine Dept.
GENERAL ELECTRIC
1000 Western Avenue • West Lynn, Mass.

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If you have had professional experience and want to take advantage of increasing opportunities for professional advancement—SEE US:

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- **Development**
- **Design**

in

Bearing and Friction Materials

Conduct studies to expand knowledge of frictional and wear properties of lubricated and unlubricated bearings, washers and seals with emphasis on high speed, high temperature applications.

Please write: E. A. Gentry, Personnel Manager

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The Clevite Research Center develops new principles and new products for other units of Clevite Corporation. It is a young organization where good work is quickly recognized. Your professional growth will be accelerated by your association with people from other fields such as physics, electronics and chemistry.

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Graduate Mechanical Engineer with at least 10 years' experience in Rayon Industry, preferably in staple, to take charge of Engineering Department. Scope of position covers maintenance, power, design and construction. Administrative ability required.

Please send full resume and salary requirements to:

HARTFORD RAYON COMPANY
Rocky Hill, Connecticut

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To direct the activities of a recently established Central Engineering Department for a multi-plant corrugated and folding box operation. A Mechanical Engineering degree is preferred and experience in the design and development of automatic machinery for the Box Manufacturing or Paper Converting fields is required. A background of close association with production problems and production personnel is also essential. The location will be in the East. Replies will receive prompt and confidential consideration.

Address CA-6025, % "Mechanical Engineering."

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DESIGN

TESTING

PRODUCTION

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Design, development, testing, and operation of nuclear reactors and component parts for research, production, power, and aircraft propulsion.

Design and development of pilot and production plants and processes in the over-all atomic energy programs.

Production of barrier and barrier materials, fluorine, and UF6 feed, all directly associated with the concentration of U-235; radioactive and stable isotopes; and special materials required for reactor and other atomic energy programs.

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GASEOUS DIFFUSION PLANTS, OAK RIDGE, TENN. AND PADUCAH, KY.
OAK RIDGE, NATIONAL LABORATORY
OAK RIDGE Y-12 PLANT

Exceptional opportunities, modern and unique facilities, liberal benefit plans, educational and training programs, plant interview and moving expenses, moderate climate, year around outdoor recreational activities, low cost living, available housing.

Send resume and salary information to

TECHNICAL PERSONNEL OFFICE

UNION CARBIDE NUCLEAR COMPANY

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Thermal Power Plant Engineering

Exceptional opportunity with major engineering firm for executive engineer with M.E. or E.E. degree (power option), 10 to 15 years progressive experience in design, layout and project engineering of thermal power plants.

Excellent salary, live in mild West Coast climate, year around recreation, new schools. Unique perquisites—free family health plan, retirement, moving allowance, etc. Unlimited future, challenging assignment.

Write in strictest confidence, stating salary required.

Address CA-6021, % "Mechanical Engineering."

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Mechanical Engineer with College Degree and five years' experience desired by Midwest public utility in high pressure power plant operation. Good working conditions and employee benefits.

Write stating education, experience, salary expected, and availability. All replies will be held confidential.

Address CA-5954, % "Mechanical Engineering."

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AGE UNDER 35. PETROLEUM REFINERY EXP. DESIRABLE.

Technical work in small expanding department of a MAJOR OIL CO. New York City location with some travel entailed.

Excellent opportunity for man with initiative. Salary commensurate with experience. Fine employee benefits program.

Send full qualifications together with resume.

Address CA-5955, % "Mechanical Engineering."

Does your family count?

One of the major reasons why Raytheon is attracting so many engineers is because Massachusetts, where most of Raytheon's plants are located, is an exceptionally fine place to live and bring up a family. A stimulating four season climate, above average schools and colleges, good and abundant water, the medical, cultural and research center of the world and nearness to all year 'round recreational advantages make it ideal. Your choice of urban or suburban living.

Raytheon as prime contractor for the Army, Navy and Air Force in guided missiles, and pioneer in the field of Doppler Radar Aircraft Navigation and Control Systems offers vital, interesting work, excellent salary and advancement prospects, modern facilities, company assistance in advanced engineering courses, relocation expenses, liberal vacations, group life & health insurance.

If you are interested in the design and development of guided missile or aircraft radar systems and have experience in these fields:

Hydraulics	Heat Transfer
Servomechanisms	Structures
Mechanical Design	Tool Design
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Come in or send brief resume to:

G. P. O'Neil

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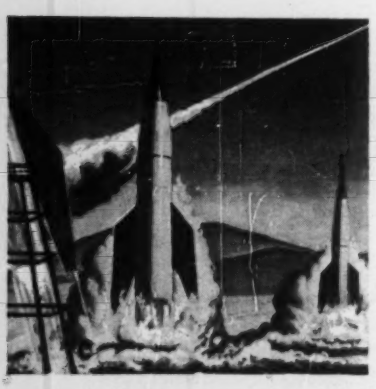

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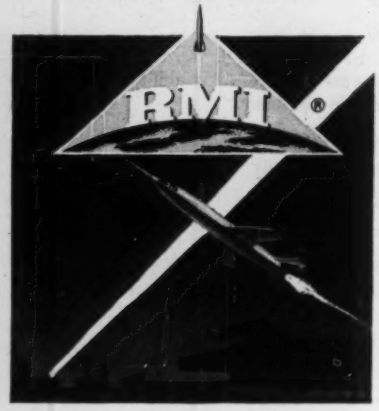

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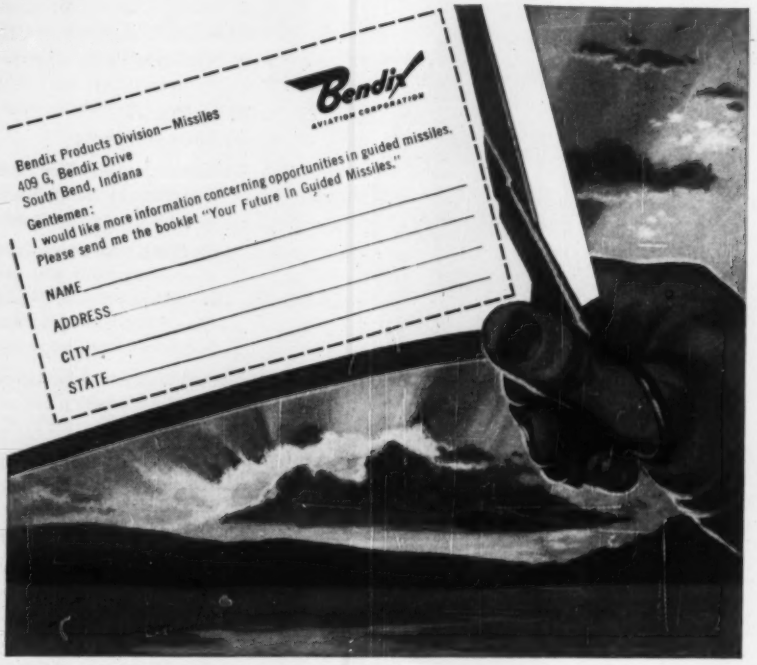

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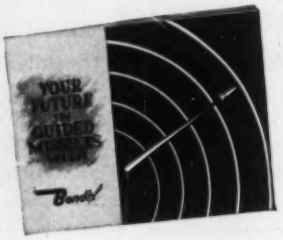

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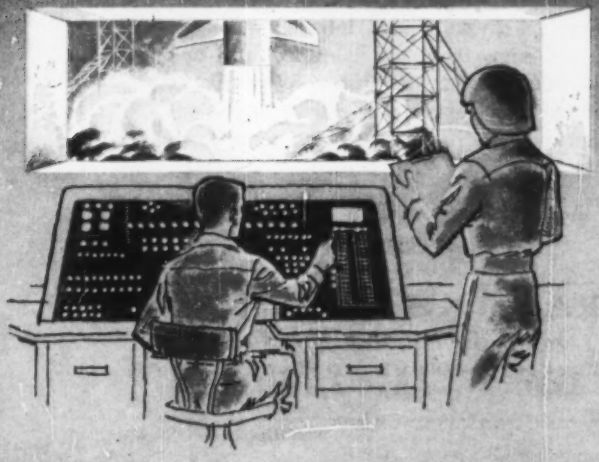

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Joe Braddick, Fairfax 3-2401, Houston, Texas
Bill Milligan, Tucker 1549, Los Angeles, Calif.
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News for Mechanical Engineers...

Lockheed breaks ground on new flight test engineering center

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Structural Flight Measurement

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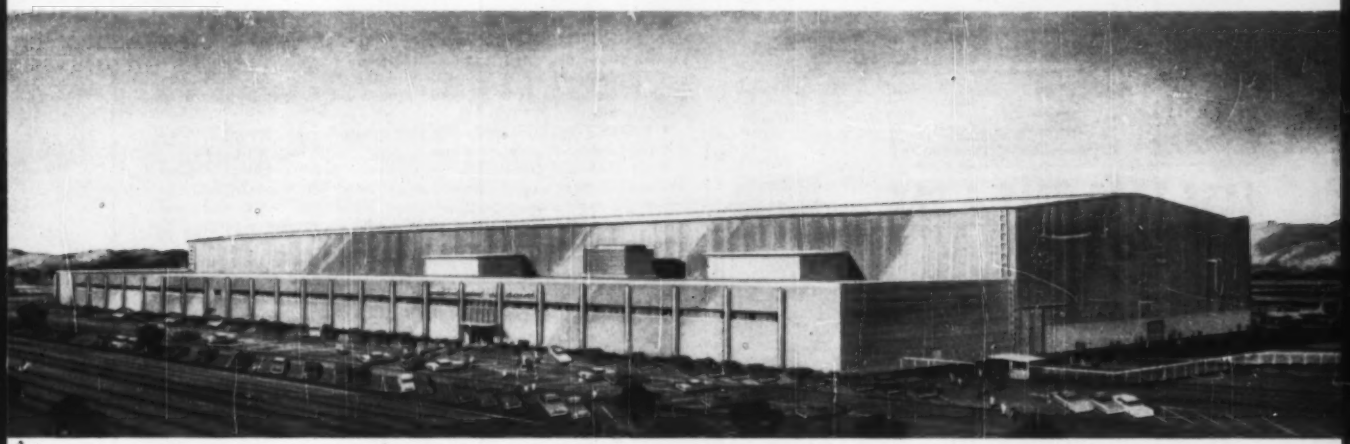

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Coffinberry, A. S. and Ellinger, F. H.

"Time-of-Flight Techniques Applied to Fast Neutron Measurements,"
Cranberg, L.

"Gamma Rays from Neutron Inelastic Scattering,"
Day, R. B.

"Some Techniques for Measurement of Fast Neutron Flux,"
Diven, B. C.

"Los Alamos Power Reactor Experiments,"
Froman, D. K., Hammond, R. P. and King, L. D. P.

"The Preparation of Kilocurie La 140 Sources,"
Hammond, R. P. and Schulte, J. W.

"Chemical Processing in Intense Radiation Fields,"
Hammond, R. P.

"The Role of Liquid Scintillators in Nuclear Medicine,"
Hayes, F. N., Anderson, E. C. and Langham, W. H.

"Delayed Neutrons,"
Keepin, Jr., G. R. and Wimett, T. F.

"Liquid Scintillation Counting of Natural Radiocarbon,"
Hayes, F. N., Anderson, E. C. and Arnold, J. R.

"Design and Description of Water Boiler Reactors,"
King, L. D. P.

"Determination of Fission Quantities of Importance to Reactors,"
Leachman, R. B.

"A Review of Americium and Curium Chemistry,"
Penneman, R. A. and Asprey, L. B.

"Techniques for Measurement of Neutron Cross Sections and Energy Spectra for Sources Which are Continuous in Energy and Time,"
Rosen, L.

"Techniques for Measuring Elastic, Non-Elastic and Transport Neutron Cross Sections,"
Taschek, R. F.

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Walt, M.

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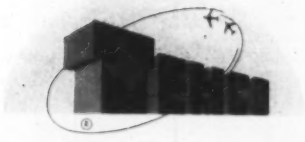

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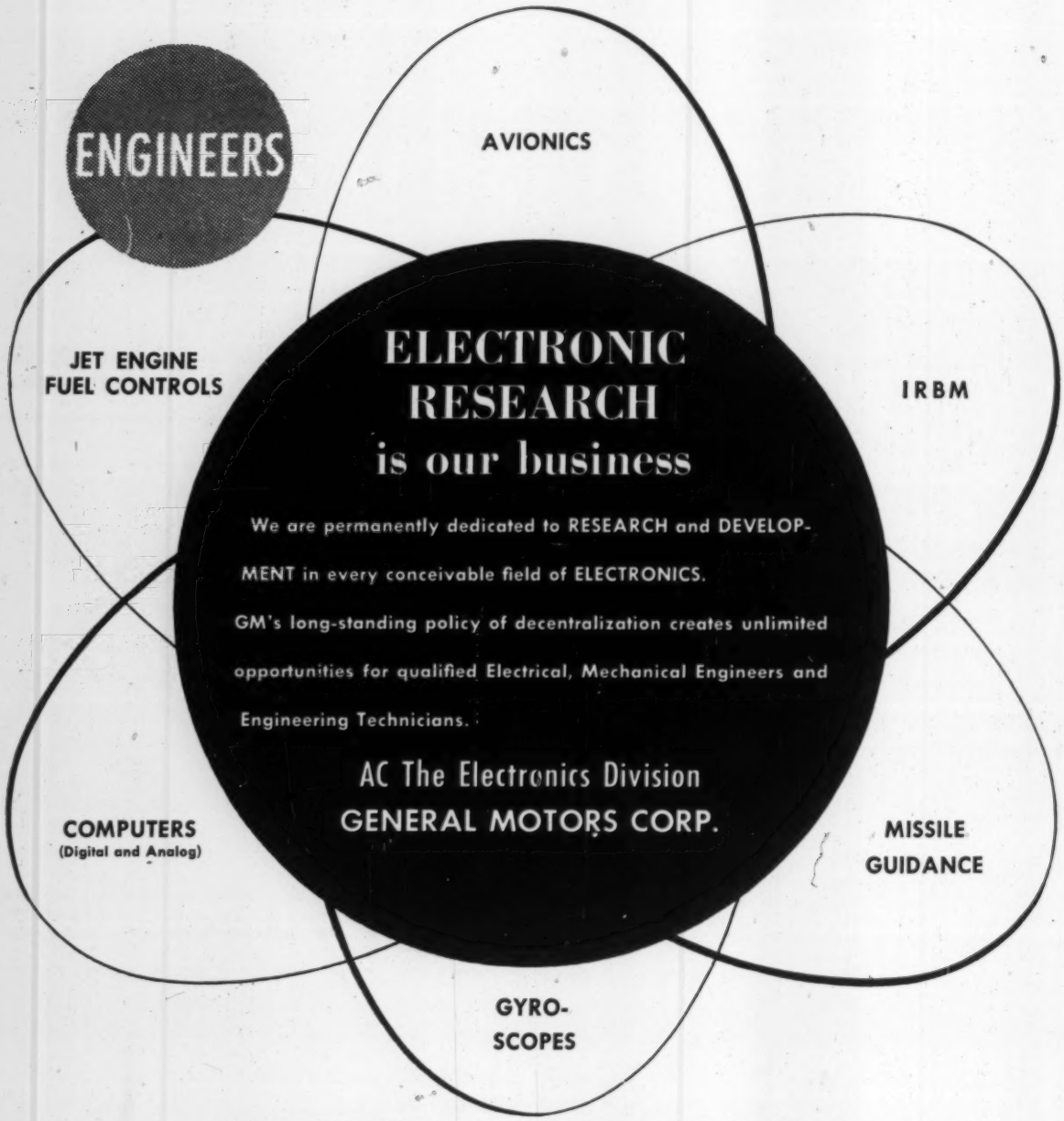
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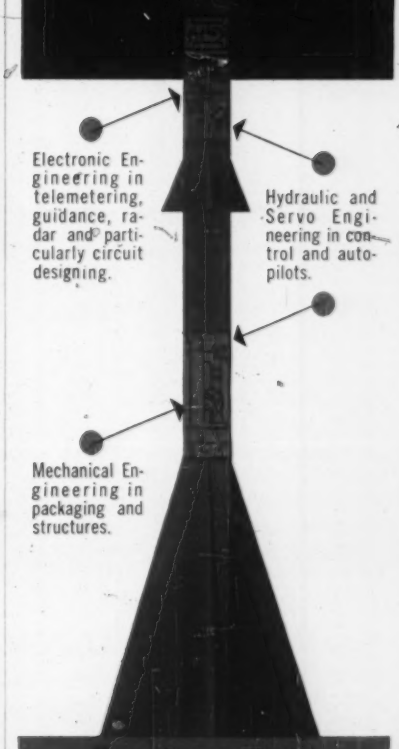
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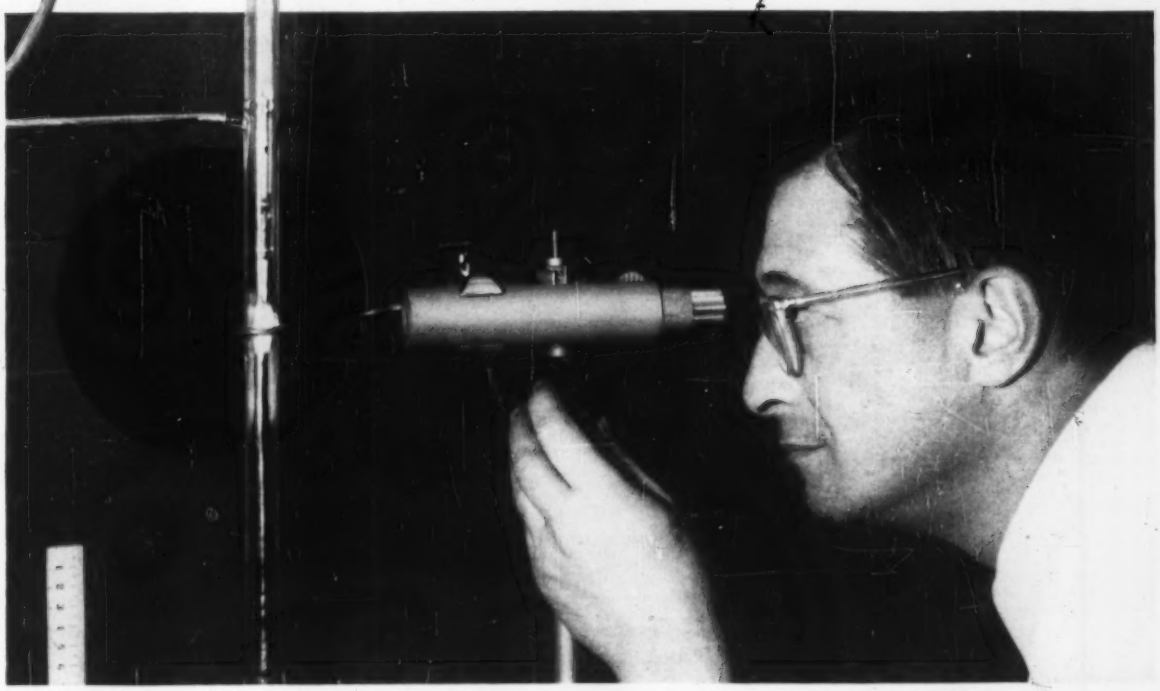

Metallurgist Henry C. Theuerer, M.A. in Chemistry, Columbia, watches a molten zone in a silicon rod under purification. Mr. Theuerer's most recent achievement was development of water-vapor treatment for removal of boron.

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Ackerman Engravers
Acushnet Process Company
*Adsco Industries (Inc.)
Aero Research Instrument Co.
*Aldrich Pump Co.
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*Cleaver-Brooks Co.
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Copperweld Steel Co.
Coxhead, Ralph C. Corp.
Crane Packing Co.
Cratex Co.
*Detroit Stoker Co.
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*Dresser Industries (Inc.)
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Synchro-Start Products (Inc.)

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*Titusville Iron Works Co.
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U. S. Pipe & Foundry Co.

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*Wickes Boiler Co.
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Wingeler Mfg. & Tool Co.
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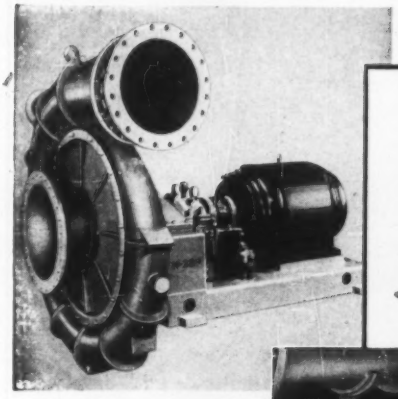

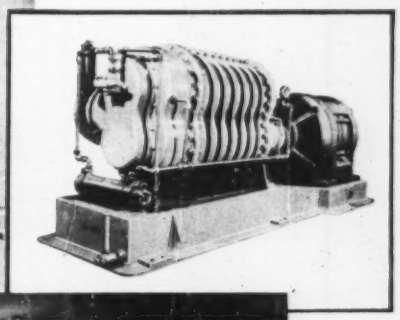

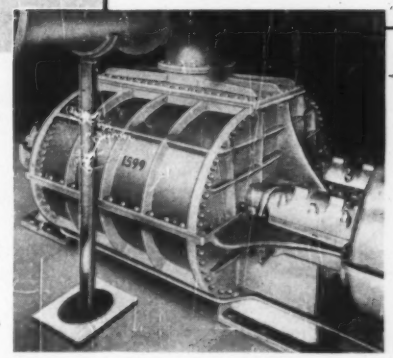

- Above: R-C Centrifugal Exhausters, in capacities up to 100,000 cfm.
- Upper right: R-C Spiraxial Compressors, from 700 cfm to 5,000 cfm.
- Right: R-C Rotary Positive Blowers, sized from 5 cfm to 50,000 cfm.

R-C *plur-ability* PAYS DIVIDENDS WHEN MOVING AIR OR GAS

Where quantity and quality of production depend upon the reliable, economical performance of blowers, exhausters and related equipment, look to the values of *R-C plur-ability*.

- choice of centrifugal, rotary positive and Spiraxial® types, an exclusive advantage of Roots-Connersville.
- accurate control of volume and pressure.
- ample choice of capacities, from 5 cfm to 100,000 cfm.
- high efficiencies and low operating costs.
- low down-time and maintenance expense.
- long-time durability.

All these factors add up to *R-C plur-ability*. They work for you in machines which you buy for your own use, or for resale with your equipment, where handling gas or air at moderate pressures is required. Our engineering experience and ability are at your service.

You'll find R-C plur-ability in all these products

Centrifugal and Rotary Positive Blowers, Gas Pumps and Exhausters

• • •

Spiraxial® Compressors

• • •

Positive Displacement Vacuum Pumps and Meters

• • •

Inert Gas Generators

• • •

Whether you use or sell equipment using gas or air at moderate pressures, check *R-C plur-ability*.

ROOTS-CONNERSVILLE BLOWER

A DIVISION OF DRESSER INDUSTRIES, INC.

1256 Michigan Avenue, Connersville, Indiana. In Canada—629 Adelaide St., W. Toronto, Ont.

are you killing that still, small voice?

When that voice prods your professional ego with, "You can do bigger and better things!," do you smother it with a wet blanket of doubt?

And when that same voice whispers to you of a gentle climate where the snow is yours just for the asking and sunshine is always yours for the basking, do you clobber it with the sledge hammer of self-denial?

Don't kill that voice! Its wisdom could lead you to a place where you'll find those bigger things, that better life—Firestone. If you've a mind that can matter in the guided missile field, Firestone needs you in its vital development program for the Army's "Corporal," first surface-to-surface guided ballistic missile. Here are just a few of our needs:

Flight Simulation
Electronics Systems
Missile Component Design
Systems Analysis
Structural Design
Field Engineering

Next time you hear that still, small voice, don't reach for your shotgun. Reach for your pen. Write—right now! Let that still, small voice guide you to big accomplishment for you, big happiness for your family!

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GUIDED MISSILE DIVISION

RESEARCH • DEVELOPMENT • MANUFACTURE

"Find your Future at Firestone"– Los Angeles • Monterey

WRITE: SCIENTIFIC STAFF DIRECTOR, LOS ANGELES 54, CALIF.

1000

BRINELL DURACASE TRIM...

Stops galling and erosion

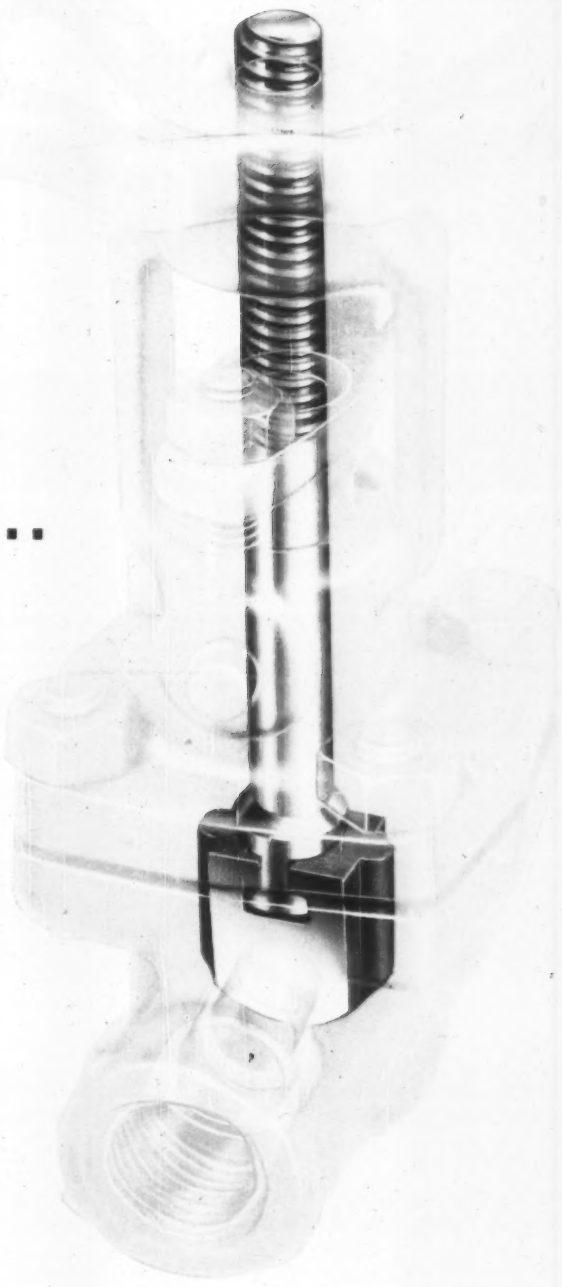
Since the introduction of OIC's Duracase Trim, many forged steel valve specs are obsolete. This 13% chrome stainless steel trim with 1000 Brinell, case-hardened wedges and discs assures positive protection against even the simultaneous attack of the three valve-destroying agents—corrosion, erosion, galling.

OIC offers you a choice of two modern body-bonnet connections—union ring or bolted bonnet—on its entire forged steel gate, globe, angle, and check valve line.

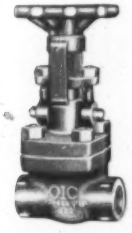
In addition, gate valves offer a choice of standard-flow or high-flow body ports, both with 1000 Brinell wedges.

Step up your valve requirements to the modern high-quality standards reflected in OIC valves. Include OIC on your next specification.

For OIC forged steel valve specification literature, write for Forms No. 195 and 195-R.



THE OHIO INJECTOR COMPANY • WADSWORTH, OHIO



OIC VALVES | FORGED & CAST STEEL, LUBRICATED PLUG, BRONZE & IRON VALVES

How TIMKEN® bearings maintain spindle precision, accurate gear mesh on extra heavy-duty lathe

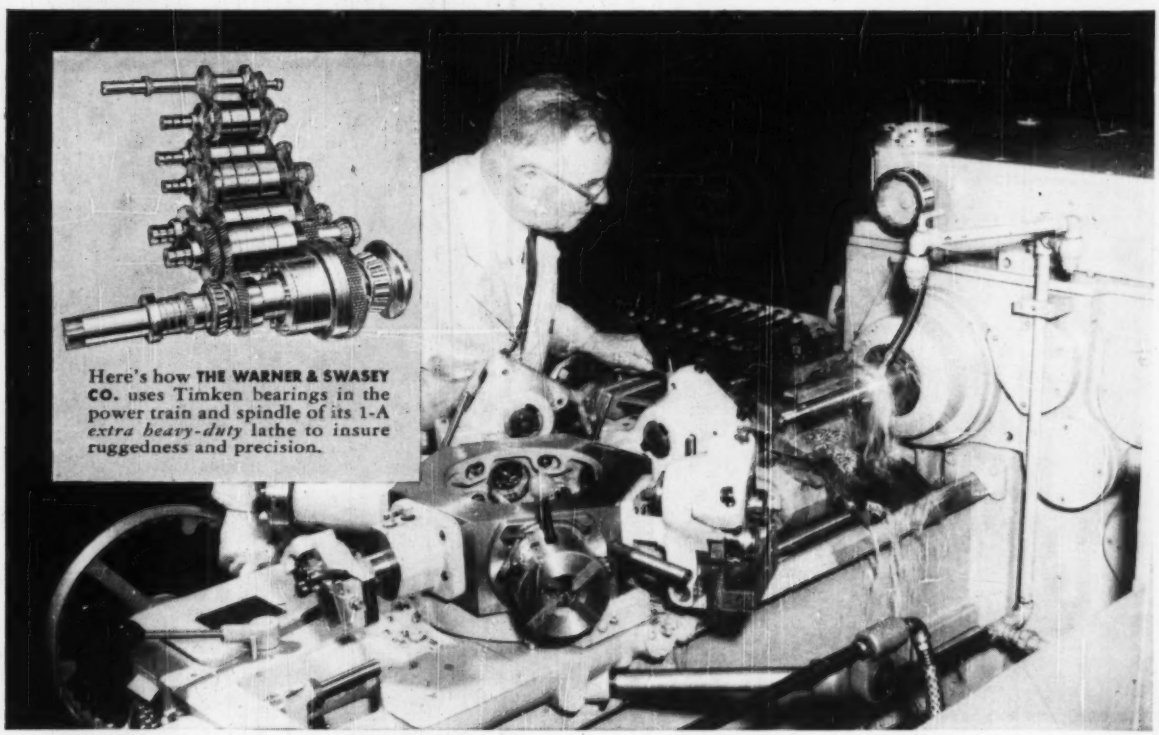
AT the flick of a lever, the operator of this Warner & Swasey 1-A, *extra heavy-duty* lathe can get any one of 16 spindle speeds immediately. Then, with the right speed for the job, this lathe can hog off a lot of metal fast—and still turn out close-tolerance parts.

To help assure both precision and ruggedness, at any speed, Warner & Swasey engineers have mounted the spindle and gear train on Timken® tapered roller bearings. Timken bearings maintain spindle precision and accurate gear mesh day in and day out, piece after piece. They're tapered to take both radial and thrust loads, in any combination. Full line contact between rollers and races provides maximum capacity. Shafts are held in alignment. Gear mesh is smoother, more accurate. Shaft wear is eliminated, gear wear reduced.

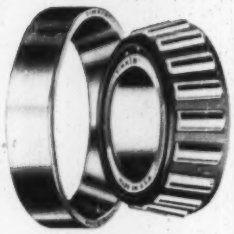
True rolling motion, plus almost microscopically smooth surfaces combine to make Timken bearings practically friction-free. They're made from Timken fine alloy steel. We're the only bearing manufacturer in America that makes its own steel. Rollers and races of Timken bearings are case-hardened for hard, wear-resistant surfaces and tough, shock-resistant cores.

No other bearings can offer you all the advantages of Timken bearings. That's why so many manufacturers of fine equipment use them. Whether you build or buy machinery, be sure to specify Timken bearings. And look for the trade-mark "Timken" stamped on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



Here's how **THE WARNER & SWASEY CO.** uses Timken bearings in the power train and spindle of its 1-A *extra heavy-duty* lathe to insure ruggedness and precision.



TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

REVOLUTIONARY BUCYRUS PLANT HELPS HOLD DOWN RISING COSTS

At a new plant in Bucyrus, Ohio, the Timken Company has substantially reduced the cost of tapered roller bearings by: 1) producing these bearings under a new system of extreme mechanization; 2) standardizing on 13 bearing sizes with the widest applications throughout industry. Manufacturers can take advantage of these lower costs by redesigning applications to use these Bucyrus sizes. And as more switch to Bucyrus bearings, production costs can drop still further, meaning even lower costs to you.

NOT JUST A BALL ○ NOT JUST A ROLLER ⊂⊃ THE TIMKEN TAPERED ROLLER ⊂⊃ BEARING TAKES RADIAL ⇩ AND THRUST →⇩← LOADS OR ANY COMBINATION →✳←